

APPENDIX L:

Original Risk Assessment (Modified)

APPENDIX L

ORIGINAL RISK ASSESSMENT (Modified)

(from IRA Plan Modification for RTN 3-33101, submitted in April 2016)

Note: Subsequent to the submittal of the Original Risk Assessment: (1) additional potential repositories (four dry wells) were located in the courtyard and are identified in this revision, and (2) minor error (assumed exposure of 5 days per week instead of 7 days per week during construction period) was discovered in the residential risk assessment worksheet (cancer) and the error is corrected in this modified risk assessment.

The Immediate Response Action (IRA) was initiated entailing excavation of certain volumes of soil. Soils containing more than 50 mg/kg PCBs (i.e., SP-1 and B-11 PCB hot spot soils) have been excavated and transported to a hazardous waste facility permitted to accept soils containing >50 mg/kg PCBs. The soils from the SP-2 stockpile were placed in the coal chute repository. The 0-1 foot interval soils from the east portion of the courtyard were excavated and placed in the coal chute repository and/or dry wells. The 0-1 foot interval soils from the west portion of the courtyard were excavated and placed in the dry wells. Excavation of the 1-3 foot interval soils from the eastern courtyard, near the fuel oil vault, was started and approximately 2 to 2.5 feet was excavated before the IRA activities were temporarily stopped, due to the presence of asbestos in shallow soils. These soils (approximately 400 cubic yards) were placed in a stockpile on the west end of the courtyard. This risk assessment was not modified to reflect these changes.

Asbestos is present in shallow soils. This risk assessment does not address the risks associated with asbestos exposure. An assumption is made that all asbestos-contaminated soils will be excavated and either transported off-site for appropriate disposal or placed in an on-Site soil repository.

The following risk assessment was prepared in accordance with the Massachusetts Contingency Plan (MCP), guidance provided by MassDEP in *Guidance for Disposal Site Risk Characterization in Support of the Massachusetts Contingency Plan* (updated in 1996), and subsequent technical updates. This risk assessment is an element of a Risk Characterization described at 310 CMR 40.0900. The purpose of this risk assessment is to determine what soil volumes within the courtyard are consistent with a finding of No Significant Risk of Harm (either with or without assumptions that would limit future uses or activities at the Site); and what soil

volumes within the courtyard have a finding of Significant Risk of harm and must be remediated. This risk assessment is being conducted to determine what must be done with the PCB-contaminated soils of the courtyard, before continued IRA activities to address the no. 6 fuel oil contamination can be conducted.

This risk assessment entails a site-specific assessment of the risk of harm to human health from exposure to courtyard soils. Exposure to other media (i.e., indoor air or groundwater) is unlikely to be factors, because: (1) the contaminants detected in the courtyard soils are generally not volatile; and (2) the depth to groundwater is more than 15 feet below grade based on monitoring well gauging conducted as part of a limited site investigation in August 2015.

The characterization of risk of harm to safety, public welfare and the environment will be conducted at a later date. This risk assessment is the same as a MCP Method 3 Human Health Risk Characterization, and relies on detailed information about the Site, the nature, magnitude and extent of OHM in each affected media, migration pathways of the OHM, and potential exposures to human receptors under all current and reasonably foreseeable Site activities and uses. This risk assessment excludes the no. 6 fuel oil contamination located from the bottom of the no. 6 fuel oil vault(s) to at least 15-20 feet below grade (Table 1 of IRA Plan Modification No. 3) and that has impacted groundwater more than 15 feet below grade (Table 2 of IRA Plan Modification No. 3).

Site and Receptor Information

Identification of Contaminants of Concern

According to the *Guidance for Disposal Site Risk Characterization*, chemicals detected at a disposal site should be considered contaminants of concern (COC) and should be carried throughout the risk assessment process unless one of the following conditions is true: (1) the chemicals are present at a low frequency of detection and in low concentrations; (2) the chemicals are present at levels consistent with background concentrations for the area and there is no evidence that their presence is related to activities at the site, or; (3) the chemicals are field or laboratory contaminants. Based on the results of the investigations conducted at the Site, soil is the media known or suspected to be impacted by oils or hazardous materials (OHM).

For the 0-15 foot interval, laboratory analyses were conducted only for soils. No groundwater was encountered within the top 15 feet of overburden. No indoor air sampling and analysis was conducted, because the contamination detected within the top 15 feet are not volatile (only very low levels of aromatic VOCs were detected). The soil analytical data considered in this risk assessment are summarized in Table 1 of the IRA Plan Modification No. 3 for all OHM except PCB congeners and in Tables 6.1 to 6.4 of the IRA Plan Modification No. 3 for PCB congeners; the

data used in the risk characterization excludes that collected after April 2016. Soil is the only media of concern for this risk assessment.

For this risk characterization, the OHM detected in soils were evaluated and the soil COC were identified in Table C-1. PCBs, EPH subsets, PAHs, metals and insecticides were detected in soils. During soil boring, coal ash, gasified coal and coal pieces were observed in the soil throughout the courtyard area. For metals and PAHs detected in soils, the MassDEP's background concentrations for soils associated with fill containing wood or coal ash were identified as appropriate for the Site. No published background concentrations exist for PCBs, EPH subsets, VOCs and insecticides; therefore, the background concentrations for these OHM are identified as zero.

The OHM detected in soils were evaluated to identify soil COC for the risk assessment, as documented in Table C-1. For metals and PAHs, this entailed comparing the maximum level detected to the applicable published background concentration.

The following metals were detected in one or more soil samples: antimony, arsenic, barium, beryllium, cadmium, chromium, lead, mercury, nickel, thallium, vanadium and zinc. As documented in Table C-1, the following metals were always detected at levels consistent with or less than MassDEP's published background concentrations: antimony. Both arsenic and cadmium were detected in one of 24 and 22 samples, respectively, at levels above published background concentrations for fill associated with fill containing coal ash or wood ash. Arsenic and cadmium were detected at an elevated concentration in the sample collected from stockpile SP-1, which will be removed from the Site. Antimony, arsenic and cadmium were eliminated as soil COC. Mercury was detected in two of 20 soil samples, and only slightly above its published background concentration. Its presence is likely due to the prevalence of coal ash in the soils; mercury was eliminated as a soil COC. Thallium was only detected in one soil sample, which was collected from the sands in the FO-1 vault, at a level above its published background concentration. Thallium is eliminated as a soil COC for all exposure points and soil intervals, except for the FO-1 vault sands.

For chromium, the maximum concentration detected was 160 mg/kg in the soil sample from stockpile SP-1. No Cr VI was detected (<4.9 mg/kg) in the soil sample from SP-1; therefore, it is not a soil COC. The chromium species is presumed represented by Cr III.

SVOCs that were detected included 17 PAHs, 2 phthalates and dibenzofuran. The PAHs are likely associated with the presence of coal ash, even though 15 PAHs were detected at levels above their published background concentrations. They were retained as soil COCs because in some samples the levels of PAHs were substantially above the published background concentrations. Two of the PAHs (i.e., acenaphthylene and 2-methylnaphthalene) were detected at levels below their published background concentrations for fill associated with soils containing coal ash or wood ash. However, both PAHs were retained as soil COC, because they are related to the other PAHs.

Dibenzofuran is a constituent of the C11-C22 aromatic hydrocarbon subset of EPH; therefore, it is eliminated as a separate soil COC. Bis(2-ethylhexyl)phthalate and di-n-butylphthalate were detected in soils of SP-1, which are slated for removal from the Site. Therefore, the phthalates were eliminated as soil COC.

The three EPH subsets (C9-C18 aliphatic hydrocarbons, C19-C36 aliphatic hydrocarbons and C11-C22 aromatic hydrocarbons) were detected in the soil samples and are retained as soil COC. No VPH subsets were detected, and therefore no VPH subset is a soil COC. The only VOCs detected were benzene and toluene in soil samples collected from the gasoline UST tank grave. They were detected at very low concentrations (maximums of 0.15 and 0.60 mg/kg, respectively), but were retained as soil COC.

PCBs were detected in soils and are included as soil COC. Fifty-three soil samples were collected for analysis of PCBs, and PCBs were detected in 40 of the samples. The principal PCB mixture detected was Aroclor 1254. Only one sample contained another PCB mixture – Aroclor 1260. This sample (B-11-r10b 0-1') contained 6.2 mg/kg Aroclor 1254 and 0.75 mg/kg Aroclor 1260. PCBs are identified as soil COCs.

Four soil samples were collected for analysis of PCB congeners (Table 6.1 to 6.4 of this IRA Plan Modification No. 3). One soil sample contained a low concentration of total congener PCBs (0.025 mg/kg) and was eliminated from complete evaluation. USEPA's document, Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin (TCDD) & Dioxin-Like Compounds (EPA/100/R 10/005/ December 2010), identifies twelve TCDD dioxin-like PCB congeners. Of these twelve TCDD dioxin-like congeners, eight were detected in the soil samples (Table C-7). Combined, these eight TCDD dioxin-like PCB congeners comprise between 9.9 and 11% of the total PCB congeners (Table C-9). The eight TCDD dioxin-like PCBs were retained as separate COCs.

Table C-1 provides a list of the soil COC. The soil COC are also identified as COC for dusts.

Identification of Groundwater and Soil Categories

During a Method 3 risk characterization, soil and groundwater categories are identified to aid in the development of potential receptor exposure profiles and to identify applicable or suitably analogous standards as described in 310 CMR 40.0933(3).

Groundwater Categories

MCP groundwater categories are established by MassDEP for the characterization of risk at disposal sites; these categories describe the potential for different types of exposure. Appropriate

groundwater categories are identified, based on site characteristics, site activity and use, and the nature and extent of the release, in accordance with the MCP (310 CMR 40.0932).

The groundwater categories describe the potential for three different types of exposure. Groundwater at all disposal sites shall be considered a potential source of discharge to surface water and shall be classified, at a minimum, as category GW-3 [310 CMR 40.0932(3)]. GW-2 groundwater is considered to be a potential source of vapors of OHM to indoor air [310 CMR 40.0932(6)]. GW-1 groundwater is considered a potential or actual supply of potable water [310 CMR 40.0932(4)].

A targeted file search was conducted to obtain information to assist in groundwater categorization. Based on a search of MassDEP's SearchWell Application database, fourteen domestic water supply wells exist in Lowell. They are identified below:

Lot 6 Dodge Road	35 Cannington Street	Lot 58 (address unknown)
537 School Street	62 Weston Avenue	Sheehan
346 Boylston Road	Route 133	358 Boylston Street
241 Pawtucket Boulevard (listed twice)	37 Second Avenue (listed twice)	1195 Varnum Avenue
Acropolis Road		

The only roads located within or slightly more than 500 feet from the Boiler House courtyard are the following: (1) Massmills Drive, (2) Bridge Street, (3) Stackpole Street, (4) Fayette Street, and (5) Brown Street. None of the active private potable drinking water wells are located on addressed on these roads, and, therefore, are not located within 500 feet of the Site. [\[http://public.dep.state.ma.us/searchwell/\]](http://public.dep.state.ma.us/searchwell/)

Based on the MassDEP Phase I Site Assessment Map (provided as Figure 3 in the original IRA Plan), the Site is not located within or near an Actual or Potential Drinking Water Source Area.

Based on monitoring well gauging conducted for courtyard monitoring wells in August 2015, depth to groundwater ranged between 19.9 and 22.7 feet below grade. This information is provided in the September 9, 2015 *Limited Site Investigation* report, prepared by GEC. Based on the available information, the following MCP groundwater categories are applicable to the site.

Groundwater Category	Yes	No	Criteria
1		X	Groundwater is within Zone II of a public water Supply well. If yes the groundwater is categorized as GW-1.
1		X	1a. Groundwater is within an Interim Wellhead Protection Area of a public water supply well.
			1b. A demonstration has been made that there is no hydrogeologic connection between the groundwater and the public water supply well.
		X	If the answer to 1a is yes, and to 1b is no, then the groundwater is categorized as GW-1.
1		X	1c. Groundwater is within an area designated by the MassDEP as a Potentially Productive Aquifer (PPA).
		X	1d. Groundwater is located within a medium or high yield aquifer, but has been designated by the MassDEP as a non-PPA, due to its urban or industrial character, but site inspection indicates that this assumption does not apply.
			1e. Site-specific information on the types/transmissivity of soils shows that the groundwater is not located within the true boundary of the medium or high yield aquifer.
			1f. The groundwater within the PPA is naturally brackish, or has naturally high levels of metals, such that the development of the aquifer is not technologically or economically feasible.
		X	If the answer to 1c or 1d is yes, and the answer to 1e or 1f is no, then groundwater is categorized GW-1.
1		X	Groundwater is within Zone A of Class A surface water body. If yes, the groundwater is classified as GW-1.
1		X	1g. Groundwater is located 500 feet or more from a public water system distribution pipeline.
	X		1h. The groundwater is located on a parcel of land or at a facility where any portion of that parcel or facility is located within 500 feet from a public water supply distribution pipeline.
		X	If the answer to 1g is yes, and to 1h is no, then groundwater is categorized GW-1.
1		X	1i. Groundwater is located within 500 feet of a private potable water supply well that was in use at the time of notification pursuant to 310 CMR 40.0300, and was installed in conformance with applicable laws, by-laws or regulations.
			1j. The private well(s) has been removed from service, and meets the conditions specified in 310 CMR 40.0932(d)(1).
			1k. It has been demonstrated that no hydrogeologic connection exists between the groundwater and private well(s).
		X	If the answer to 1i is yes, and to 1j or 1k is no, then the groundwater is classified as GW-1.
1		X	Groundwater is located within a locally designated Potential Drinking Water Source. If yes, then groundwater is categorized as GW-1.

Groundwater Category	Yes	No	Criteria
2	X		2a. Groundwater is located within 30 feet of an existing occupied building or structure
		X	2b. The annual average depth to groundwater in that area is 15 feet or less
		X	Do both 2a and 2b apply? If yes, the groundwater is categorized GW-2
3	X		Groundwater at all disposal sites is considered a potential source of discharge to surface water and is classified as GW-3

Soil Categories

MCP soil categories S-1, S-2, and S-3 describe a range of potential exposures to a particular volume of soil. Soil category S-1 is associated with the highest exposure potential, and category S-3 is associated with the lowest exposure potential. In this section, appropriate soil categories are identified for the site based on soil accessibility, intensity and frequency of use, and on the age groups of potential receptors.

The three soil categories describe a range of the potential for exposure to soil. Three criteria, defined below, are used to describe the exposure potential for the purposes of categorizing soil:

- 1) Frequency of use, which indicates how often a receptor makes use of, or has access to, the disposal site; high frequency for children is valid if children reside, attend school or attend day care at the disposal site, or if large numbers of children visit the disposal site; high frequency for adults is valid if adults reside at the disposal site, or work at the disposal site on a continuing basis;
- 2) Intensity of use, which describes the nature of the Site Activities and Uses that could potentially result in exposure to the receptor; high intensity activities include digging, gardening and recreational sports; passive activities, such as, walking, shopping and bird watching, are considered low intensity activities;
- 3) Accessibility of the soil to potential receptors, which is characterized as one of the following: "accessible"; "potentially accessible"; or "isolated" [310 CMR 40.0933].

Soil categories are assigned to specific volumes of soils. For current scenarios, the appropriate soil category for a specific soil volume is based on current site conditions, uses, and the age of the receptor. For future conditions, the soil category is assumed to be S-1 unless assumptions are used to limit future activities and uses. A matrix, which is used to select the appropriate current and future soil categories for each volume of soil on site, is provided below.

Receptor Characteristics

Access. Of Soil	Children Present				Adults Only Present			
	High Frequency		Low Frequency		High Frequency		Low Frequency	
	High Intensity	Low Intensity	High Intensity	Low Intensity	High Intensity	Low Intensity	High Intensity	Low Intensity
AS	Category S-1			S-2	S-1	Category S-2		
PAS	Category S-2				S-2	Category S-3		
ISS	Category S-3							
* Category S-1 also applies to any accessible soil where current or reasonably foreseeable use of the soil is for growing fruits and vegetables for human consumption								

AS = Accessible (Surficial) Soil (0 to 3 feet deep, unpaved)

PAS = Potentially Accessible Soil (3 to 15 feet, unpaved; 0 to 15 feet, paved)

ISS = Isolated Subsurface Soils (greater than 15 feet or under the footprint of a building or permanent structure)

Historically, the property on which the courtyard is located was used for industrial and commercial purposes. Currently, the Picker Building is being renovated into a multi-family residential complex. There are also similar plans to renovate the Boiler House into a multi-family residential complex in the future. The near-term plans for the courtyard include transforming it into a landscaped area to serve residents of both buildings. An assumption is made that a protective barrier (currently planned to be comprised of 3 feet of clean soils over a geotextile marker barrier) will be installed over the courtyard soils. This protective barrier will mitigate exposure by residents to contaminated soils, except potentially during a construction or utility repair project.

Based on the above criteria for soil classification and the current and future site uses described above, a soil category was assigned to each volume of soil for both future and current conditions, as documented below. The appropriate soil category depends on property use, the location of the exposure point where the soil volume resides, the depth interval of the soil volume, and whether the soil volume is covered by pavement, building or other barrier. Each exposure point / depth interval combination is evaluated in the charts below.

Soil Categories for Current and Future Conditions
Current and Future Conditions: Boiler House Courtyard
Location: 169.2 Bridge Street
(Residential Use: All Soil Intervals)

Soil Volume	Receptor	Criteria	Comment	Soil Category
Potentially accessible or isolated subsurface soils (all soils covered with protective barrier) *	Child – Residential	Frequency	High – presumed to live at site	S-2
		Intensity	Low – soil disturbance activities are presumed not to occur under current or future conditions, except for construction / utility work	
		Gardening	Is not and will not occur	
Potentially accessible or isolated subsurface soils (all soils covered with protective barrier) *	Adult – Residential	Frequency	High – presumed to live at site	S-3
		Intensity	Low – soil disturbance activities are presumed not to occur under current or future conditions, except for construction / utility work	
		Gardening	Is not and will not occur	
Potentially accessible or isolated subsurface soils (all soils covered with protective barrier)*	Adult – Commercial	Frequency	High – presumed to work at site	S-3
		Intensity	Low – soil disturbance activities are presumed not to occur under current or future conditions, except for construction / utility work	
		Gardening	Is not and will not occur	
Potentially accessible or isolated subsurface soils (all soils covered with protective barrier)*	Adult – Utility / Construction	Frequency	Low – presumed to work at site only during a construction or utility project	S-3
		Intensity	High – soil disturbance activities are presumed to occur	
		Gardening	Is not and will not occur	
			Soil volume	Soil Category
			Current	S-2
			Future	S-2

* An assumption is made that all soils of the Site will be covered with one or more protective barrier(s).

Soil and Groundwater Categories

In summary, the following categories apply to the soil and groundwater of the Site:

Media	Category	Location, Depth Interval and Comment
Groundwater	GW-3	Entire aquifer beneath the courtyard
Courtyard Soils	S-2	Presumed Current and Future Residential Conditions: All Soil Volumes (All soils covered with a protective barrier)
	S-3	Presumed Current and Future Commercial Conditions: All Soil Volumes (All soils covered with a protective barrier)
	S-3	Construction / Utility Work: All Soil Volumes (All soils covered with a protective barrier), except during construction / utility work

Note: The lowest soil category applicable to a soil volume, after considering all receptors and current and foreseeable uses, is provided. An assumption is made that gardening of edible produce will not occur in the future in the soils of the courtyard, except under Best Management Practices. For the courtyard, an assumption is made that future use will include multi-family residential, child school, daycare, institution, playground, active recreational, commercial, industrial or passive recreational use, but will not include single-family residences. In addition, for the exterior courtyard, all soils are presumed covered by protective barriers, except during short-term construction or utility work, which will be conducted under Site-specific Soil Management Plan. These assumptions require the implementation of a Notice of Activity and Use Limitation (AUL).

Potential Human Receptor Exposure Profiles

Human populations located at the property or on nearby properties include the following: (1) on-Site residents of a multi-family residential complex; (2) on-Site commercial workers; (3) on-Site construction workers; (4) on-Site utility workers; (5) on-Site customers / visitors / trespassers; (6) nearby residents; (7) nearby commercial workers; and (8) nearby customers / visitors / trespassers. Risks to on-Site and nearby customers / visitors / trespassers / commercial workers and nearby residents are believed to be adequately represented by on-Site residents. Children are typically considered the more sensitive receptor group; therefore, when calculating non-cancer risk, risk estimates were calculated for child residents and residents were presumed present for 30 years from age 1 to 31 years. Adult on-Site utility workers are believed adequately represented by on-Site construction workers. Risk estimates were calculated for child / adult on-Site residents and adult on-Site construction workers.

Currently, the adjoining Picker House lot is being developed for multi-family residential use. The Boiler House is currently vacant, but will be similarly developed in the future. The subject courtyard between the two buildings will be developed into green space for the future residents.

These uses are assumed to occur into the future. The courtyard is presumed covered with one or more protective barriers (such as three feet of clean soil over a marker layer, hardscaping, pavement or a building foundation) and are assumed to remain so covered in the future.

During the risk characterization, assumptions were made that prohibit certain future uses and activities. For the exterior courtyard, future property use is presumed to not include single-family residences. It is also presumed to not include gardening of edible produce, except under Best Management Practices. A protective barrier is presumed to be maintained over the PCB-contaminated soils. During excavation activities or other soil disturbance activities, soil management plans to ensure proper handling of the soils. Following excavation or soil disturbance activities, soils will be returned to the excavation or transported off-site in accordance with federal, state and local regulations; and the protective barrier will be replaced.

The exposure pathways or profiles for each target receptor group for current and reasonably foreseeable conditions are described below.

Current and Future On-Site Residents, including Children: Courtyard

This receptor is presumed to be a 1-31 year old female, who resides at a multi-family residential complex. Exposure to soils is presumed not to occur, except during a 6-month construction project, which occurs sometime during the period when the receptor is aged between 1 and 2 years. The receptor is presumed to weigh 10.7 kilograms (kg) during this period.

Based on future conditions, this receptor may be exposed to soil contamination via dermal contact and incidental ingestion, 7 days per week, for 26 weeks. Dermal contact is presumed to occur to face, hands, forearms, lower legs and feet. Incidental ingestion of soil is presumed to occur at a rate of 100 mg/day. More frequent exposure to soils is presumed limited by implementation of a soil management plan. During the construction project, inhalation of dusts is conservatively presumed to occur 24 hours per day, 7 days per week for 26 weeks. During the construction period, no precautions are assumed implemented to limit the frequency of exposure.

No ingestion of home-grown edible produce is presumed to occur. Little to no volatile COC exist in the soils or groundwater is located more than 15 feet below grade; therefore, inhalation of vapors attributable to soil vapor intrusion is not an exposure pathway for the Site. No private or public water supply well is located near the Site or is likely to be located near the Site in the future; therefore, ingestion, dermal contact or inhalation of Site-related OHM in potable water is unlikely to occur.

Future On-Site Construction Workers: Courtyard

This receptor is presumed to be a 22 year old female, weighing 58 kg, who is a construction worker. She is presumed to work on-site during a future six-month construction project, for 8 hours per day, 5 days per week, for 26 weeks.

Under future conditions, the on-site construction worker may be exposed to soil contamination via dermal contact to face, hands, forearms, feet and lower legs, enhanced incidental ingestion at a rate of 100 mg/day, and inhalation of dusts presuming mild exertion. Following inhalation of dust, this receptor is presumed to cough up a portion of the inhaled dust and to then ingest the dust.

An excavation is presumed to extend to a depth of 15 feet below grade, which would not intercept the groundwater table. Therefore, no exposure to groundwater is expected to occur. Little to no volatile COC are present in the soils or groundwater; therefore, inhalation of vapors in a construction excavation is not an exposure pathway.

Identification of Exposure Points

An exposure point is a location of potential contact between a human or environmental receptor and a release of OHM. Exposure points for applicable environmental media are identified in accordance with MCP guidance and regulations [310 CMR 40.0924].

Groundwater, Indoor Air and Construction Excavation Air

No human exposure points exist for groundwater, indoor air and construction excavation air.

Soils

The following soil exposure point is presumed to exist: (1) the Boiler House courtyard. The soils of the courtyard were evaluated to determine if a hot spot of PCB contamination exists. The highest level of PCB was detected in the 0-1 foot interval of B-11. However, there was significantly variability throughout the courtyard, especially within the 0-1 foot interval, where the highest PCB levels were detected as depicted in Figure 6. Therefore, the 0-1 foot interval soils were identified as a separate soil interval requiring evaluation. Similarly, the 1-3 foot interval had higher levels of PCBs than the underlying soils; therefore, it was also evaluated separately. These soils are presumed to require remediation. Two other soil intervals, 3-6 and 3-11 foot intervals, were evaluated separately. The 3-6 foot interval is assumed to be located at utility depth, and the 3-11 foot interval is assumed located within construction depth. No soil data exists for the 11-15 foot interval; however, there was a clear trend in declining PCB, metal, insecticide and PAH levels with depth. A 3-foot layer of clean soils with a marker layer is presumed placed over the 3-6 / 3-11 foot interval soils. This clean layer of soils was not factored into deriving exposure point concentrations. The

vault sands were evaluated separately because they had soil COC concentrations that were different than the remaining soils. The soils of stockpile SP-1 contain high levels of PCBs and will be removed from the Site. The soils of SP-2 are presumed to contain elevated levels of PCBs, and will either be removed from the Site or placed in an on-Site soil depository subject to a Notice of AUL (more on soil depositories in Section 3.4). Similarly, the soils (i.e., some from the excavation of the gasoline USTs and some from the soils overlying the no. 6 fuel oil vaults) used to backfill the gasoline tank graves are presumed to contain PCBs. These soils are presumed to either be removed from the Site or placed in an on-Site soil depository.

Based on the foregoing, the following five exposure points / soil intervals were evaluated in the risk assessment: (1) 0-1 foot interval courtyard soils; (2) 1-3 foot interval courtyard soils; (3) 3-6 foot interval courtyard soils; (4) 3-11 foot interval courtyard soils; and (5) the vault sands (also called SP-3).

Dusts

For dusts in outdoor air, the exposure points are the on-Site exposure points. The soil samples, representative of exposure point concentrations at each soil exposure point, were used to calculate dust exposure point concentrations.

Identification of Exposure Point Concentrations

Except for TCDD dioxin-like PCB congeners, exposure point concentrations (EPCs) were calculated for each COC in soil for each exposure point and soil interval using measured values in collected samples (Tables C-2 to C-6). EPCs were calculated for TCDD dioxin-like PCB congeners, for input in the risk assessment as TCDD dioxin. The TCDD dioxin EPCs were calculated considering: (1) the EPCs for PCBs; (2) the portion of PCBs comprised of TCDD dioxin-like congeners (11%); and (3) the Toxicity Equivalence Factors (which was the same (3E-05) for all TCDD dioxin-like congeners detected at the Site), as documented in Tables C-7 to C-10. Note: Percent TCDD dioxin-like congener composition of PCBs was based on the congener PCB data. However, because congener PCB data was not available for most soil samples, the Aroclor PCB data was used to derive the TCDD dioxin-like PCB EPCs.

In addition, dust EPCs were estimated based on the use of a formula for air-borne particulates in ambient air. The approaches used to calculate EPCs for each COC in each environmental medium at each exposure point are described below.

The EPCs are determined consistent with Method 3 Risk Characterization, a chemical-specific approach, which estimates potential non-cancer and cancer risks for each receptor and compares these risks to MassDEP-identified risk limits. For soils and groundwater, the EPCs are the

mean, 95th percentile upper confidence limit on the mean concentration, or maximum concentrations, dependent on the type of exposure, data variability, and amount of available data. As a conservative measure, when calculating the mean or 95th percentile upper confidence limit, one-half the sample detection limit is used as a proxy concentration for samples in which a chemical was not detected.

For each COC in soils, the data sets were examined for each soil exposure point / exposure interval to determine the appropriate method to derive EPC, as documented in Tables C-2 to C-6. Except as identified below, for each OHM at each soil exposure point, the mean concentration was identified as the appropriate method to derive EPC for each COC, each exposure point and each soil interval.

Exposure Point	COC and EPC Method	Comment
All exposure points / soil intervals	PCB: 95 th PUCL	human health risk assessment; 95 th PUCL for PCB also used to derive TCDD dioxin EPC

Notes: 95th PUCL = 95th percentile upper confidence limit on the mean concentration

For dusts in outdoor air, EPCs are estimated assuming soil disturbance is occurring. The formula used is provided below. The soil EPCs are used to estimate dust EPCs. The soil EPCs are summarized in the tables of Appendices C-1 to C-6, and the dust EPCs are derived and summarized in the tables of Appendix C-6.

$$EPC_{air} = [OHM]_{soil} \times PF \times PM_{10} \times CF$$

Where:

- EPC_{air} = Exposure Point Concentration for inhalation of particulates in air (mg/m³_{air})
- [OHM]_{soil} = Soil concentration (mg_{contaminant}/kg_{soil})
- PM₁₀ = Respirable particulate concentration in air (60 µg/m³_{air})
- PF = Proportion of respirable particulate concentrations attributable to the site (0.50, unitless)
- CF = Conversion factor (10⁻⁶ kg/mg)

Characterization of Risk of Harm to Human Health

Hazard Assessment

Extent of Oil and/or Hazardous Material

The hazardous materials (comprised of PCBs, metals, PAHs and pesticides) were detected from ground surface to approximately 15 feet below grade. The highest levels of contamination were detected in the 0-1 foot interval soils, followed by 1-3 foot interval soils and gradually declined with depth. The contaminated soils are located throughout the entire courtyard. Migration pathways include those typical of hazardous materials that are relatively non-volatile and tend to bind to soils. Dust generation, surficial run-off and tracking of soils are principal migration pathways. Leaching of contaminants is not expected to be a significant migration pathway, as determined by the decline in contaminant levels with depth and, for some metals (lead and cadmium), the lack of significant leachability based on TCLP testing. Volatilization to vadose zone air, indoor air and outdoor air is not a significant migration pathway. The OHM identified as soil COC are identified in Table C-1. The background conditions are also identified in Table C-1, and Site conditions are compared to background in Table C-1.

Toxicity Profiles

A descriptive summary of human health effects associated with each COC is available from MassDEP's *Documentation for the Risk Assessment ShortForm - Residential Scenario*, or from USEPA's *Integrated Risk Information System (IRIS)*.

Dose-Response Values

The dose-response assessment relates the likelihood or severity of an adverse effect to the level of exposure. Dose-response values are provided for the following three categories: non-carcinogenic (threshold) health effects; carcinogenic (non-threshold) health effects; and relative absorption factors (RAFs), which are used to relate toxicity information identified in the literature to exposure pathways of concern at the disposal Site. Dose-response information for each COC is obtained from published literature describing epidemiological or toxicological studies. For each COC, dose-response values were obtained primarily from sources published by MassDEP and the United States Environmental Protection Agency (USEPA), i.e., the Integrated Risk Information System (IRIS) or the Health Effects Assessment Summary Tables (HEAST). The first source of dose-response values is MassDEP (i.e., toxicity values used by the MassDEP to develop MCP Method 1 Numerical Standards or provided in MassDEP's Risk Assessment Shortforms). The second source of dose-response values is USEPA's IRIS followed by USEPA's HEAST. For COCs that do not have dose-response values available through MassDEP, HEAST or IRIS, values were obtained from the USEPA's Superfund Health Risk Technical Support Center in Cincinnati, Ohio. RAFs were obtained from published sources of the MassDEP.

Non-carcinogenic Effects

For non-carcinogenic effects, a threshold is believed to exist below which a dose level or exposure level for a given OHM is not expected to result in an adverse health effect. As a result, a sub-threshold dose-response value, set in a conservative manner, would be expected to be protective of human health. Two types of sub-threshold values are Reference Doses (RfD) and Reference Concentrations (RfC). RfD is a sub-threshold dose in milligrams per kilogram body weight per day (mg/kg/day), at which daily exposure of a human population is likely to be free of adverse effects during a lifetime. RfC is an inhalation exposure concentration in milligrams or micrograms per cubic meter of air (mg/m³ or µg/m³), to which daily exposure of a human population is likely to be free of adverse effects. Wherever subchronic non-cancer dose-response values are not available, chronic dose-response values are used as surrogates. If RfC values were not available, a surrogate value was calculated via route-to-route extrapolation using the RfD.

Subchronic and chronic oral RfD values are provided in Appendices C-1 to C-6. The sources of these values are identified on the same tables.

Carcinogenic Effects

For carcinogenic effects, no threshold dose is believed to exist which is associated with no risk. The USEPA evaluates available toxicity data and, based on this evaluation, chemicals are assigned to a weight-of-evidence class. The weight-of-evidence classification rates the likelihood that an agent is a human carcinogen. Three major factors are considered in characterizing the overall weight-of-evidence for carcinogenicity: (1) the quality of evidence from human studies; (2) the quality of evidence from animal studies; and (3) other supportive information, such as mutagenicity data and structure-activity data. Historically, the USEPA used Group A to E to identify weight-of-evidence carcinogenicity ratings. These groups are presented and defined below.

Weight-of-Evidence Category	Definition
Group A - Human Carcinogen	This category indicates there is sufficient evidence from epidemiological studies to support a causal association between an agent and human cancer
Group B - Probable Human Carcinogen	This category generally indicates there is at least limited evidence from epidemiologic studies of carcinogenicity to humans (Group B1) or that, in the absence of data on humans, there is sufficient evidence of carcinogenicity in animals (Group B2)
Group C - Possible Human Carcinogen	This category indicates that there is limited evidence of carcinogenicity in animals in the absence of data on humans
Group D – Not Classified	This category indicates that the evidence for carcinogenicity in animals is inadequate, or no data are available
Group E – No Evidence of Carcinogenicity to Humans	This category indicates that there is evidence of non-carcinogenicity in at least two adequate animal tests in different species or in both epidemiologic and animal studies

More recently, as carcinogenicity is re-evaluated for a chemical, USEPA has dropped the use of group ratings and uses descriptors instead. Gradually with time, more chemicals are receiving descriptor ratings. Some chemicals descriptors are dose or route dependent. The five descriptors are as follows: (1) carcinogenic to humans; (2) likely to be carcinogenic to humans; (3) suggestive evidence of carcinogenic potential; (4) inadequate information to assess carcinogenic potential; and (5) not likely to be carcinogenic to humans. The carcinogenic potential for each COC is described based on its current description within IRIS.

Cancer Slope Factors (CSFs) and Unit Risks (URs) are the relevant toxicity criteria for assessing cancer risks. CSFs and URs are typically calculated for chemicals in Groups A, B1, and B2, and occasionally calculated for chemicals in Group C. The oral CSF is the largest possible linear slope, within the upper 95% Confidence Limit, expressed as the risk per unit dose, and is typically given in units of (mg/kg/day)⁻¹. The inhalation UR is the upper 95% Confidence Limit of the mean incremental lifetime cancer risk estimated to result from lifetime exposure to an agent if it is in the air at a concentration of 1 µg/m³ or in the drinking water at a concentration of 1 µg/L. Use of the CSF or UR assumes that the estimated dose received by a receptor is expressed as a lifetime average.

The following COC detected at the Site are listed as carcinogens: (1) nickel (inhalation only) and benzene, which are Class A carcinogens; (2) beryllium and cadmium, which are Class B1 carcinogens via the inhalation route; and (3) benzo(a)anthracene, benzo(a)pyrene,

benzo(b)fluoranthene, benzo(k)fluoranthene, chlordane, chrysene, DDD, DDE, DDT, dibenzo(a,h)anthracene, indeno(1,2,3-c,d)pyrene, dieldrin, dioxin (TCDD equivalents), lead and PCBs, which are Class B2 carcinogens. The TCDD toxicity equivalent PCBs are also carcinogens. The remaining COC are either listed as Class D or insufficient data is available on their carcinogenicity.

For nickel, beryllium and cadmium, inhalation URs are derived, but the oral CSFs are not available. For lead, too many uncertainties exist in the cancer studies to derive oral CSF or inhalation UR; therefore, lead was not included as a cancer COC. The oral CSFs and inhalation URs for each of the carcinogenic COC are provided in Appendices C-1 to C-6.

Relative Absorption Factors (RAFs)

The RAF is used to account for differences in the absorption efficiency under exposure conditions for the site compared to the absorption efficiency for the study used to develop the associated dose-response value. RAFs used in the Risk Characterization are values provided in MassDEP's excel Toxicity workbook for deriving MCP Method 1 Numerical Standards or in MassDEP's Risk Assessment ShortForms. RAF's for non-cancer and cancer COC are provided in Appendices C-1 to C-6.

Permeability Coefficients (K_p)

The K_p is a value used to estimate the rate of transfer of a chemical through the skin. K_p 's used in the Risk Characterization are values provided in MassDEP's excel Toxicity workbook for deriving MCP Method 1 Numerical Standards or in MassDEP's Risk Assessment ShortForms.. No K_p were used for this risk characterization.

Exposure Assessment

Development of Exposure Profiles

Exposure profiles are provided in the section entitled "Potential Human Receptor Exposure Profiles," above. These profiles were developed considering current and reasonably foreseeable activities and uses of the Site.

Quantitative Estimation of Exposure

Once exposure profiles are developed describing the COC, exposure points, and the receptors of concern, the potential exposures experienced by the receptors are quantified. The quantitative exposure estimates are then used to estimate risk, as described below.

The types of exposure or dose used to characterize risk depend on the exposure pathway under evaluation and the nature of the toxicity information available for each chemical. The Average Daily Dose (ADD) and Lifetime Average Daily Dose (LADD), in units of mg/kg/day, are calculated to estimate non-cancer and cancer effects from exposure to COC via incidental ingestion and dermal contact pathways. The Average Daily Exposure (ADE) and Lifetime Average Daily Exposure (LADE) are calculated and used when estimating non-cancer and cancer effects from exposure to COC via inhalation.

Estimates of exposure are provided in tables contained within Appendices C-1 to C-5 for construction workers (using MassDEP's Construction Worker ShortForm) and within Appendix C-6 for Residents (using GEC's construction worker risk assessment workbook). These same appendices provide the equations and exposure factors used to calculate exposure estimates.

Calculation of Risks

Chronic and Subchronic Non-Cancer Risk: The measure used to describe the potential for non-cancer health effects is the Hazard Index (HI). For a given chemical the HI is the ratio of a receptor's exposure level (or dose) to the "allowable" exposure level. A Hazard Index of 1.0 or less indicates that the receptor's exposure is equal to or less than the allowable exposure level, and it is considered unlikely that adverse health effects will occur. For a given route of exposure HIs are calculated as follows:

$$HI_{route-specific} = (E_1/Rf_1) + (E_2/Rf_2) + . . . + (E_i/Rf_i)$$

Where:

E_i = Non-cancer exposure intake or concentration for the i^{th} chemical; and

Rf_i = RfD (oral) or RfC (inhalation) for the i^{th} chemical.

Route-specific HIs are added to obtain a cumulative non-cancer HI for each receptor group and exposure point. The cumulative non-cancer HI for each receptor is compared to MassDEP's cumulative non-cancer risk limit, which is a Hazard Index of 1.0.

Subchronic HIs were calculated for both receptors, because exposure is presumed to occur for relatively short periods of time, such as during a one week utility repair project or during a six-

month construction project. For each COC-receptor-exposure point combination, HIs are calculated in tables provided in Appendices C-1 to C-6. For each receptor, the total cumulative HIs are compared to MassDEP's non-cancer risk limit of 1.0 in the same attachments.

Cancer Risk: The potential for carcinogenic (i.e., non-threshold) health effects is characterized as the Excess Lifetime Cancer Risk (ELCR). The ELCR represents the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen. For a given chemical, the estimated ELCR is the product of the receptor's quantified exposure and a measure of carcinogenic potency (i.e., cancer slope factor or unit risk factor). For a given route of exposure, the ELCR is calculated as follows:

$$ELCR_{route-specific} = (EI_1 \times SF_1) + (EI_2 \times SF_2) + . . . + (EI_i \times SF_i)$$

Where:

EI_i = Cancer exposure intake or concentration for the i^{th} chemical; and

SF_i = Slope Factor for the i^{th} chemical.

Route-specific ELCRs are added to obtain a cumulative ELCR for each receptor group and exposure point. The cumulative ELCR for each receptor will be compared to MassDEP's cumulative cancer risk limit, which is an ELCR equal to one-in-one hundred thousand (1×10^{-5}).

For each COC-receptor-exposure point combination, ELCRs are calculated in tables provided in Appendices C-1 to C-6. For each receptor, the total cumulative ELCR is compared to MassDEP's cancer risk of one-in-one hundred thousand (1×10^{-5}) in the same attachments.

Identification of Applicable and/or Suitably Analogous Public Health Standards

The MCP requires that the characterization of risk of harm to human health include a comparison of Site conditions to applicable or suitably analogous public health standards. No applicable or suitably analogous public health standards exist for the Site. This finding includes the USEPA's self-implementing or risk-based PCB clean-up regulations of TSCA, because the PCB release occurred before the effective date of TSCA.

Characterization of Risk of Harm to Human Health

Risk of Subchronic and Chronic Threshold (Non-Carcinogenic) Health Effects: For each receptor group, the total cumulative subchronic or chronic HI is compared to MassDEP's cumulative non-cancer risk limit of 1.0. Subchronic HI were calculated for resident and construction worker. Limits on future exposure to residents, entailing the maintenance of a protective barrier over soils were assumed. No chronic HI were calculated, because no chronic exposure exists under current and presumed conditions. The results of the non-cancer risk assessments are summarized in Appendices C-1 to C-5 for construction workers and Appendix C-6 for residents. The cumulative HIs are compared to the non-cancer risk limit in Table C-11.

Based on these findings, No Significant non-cancer Risk of harm exists for the 3-6 and 3-11 foot interval courtyard soils for both receptors, presuming that a protective barrier is maintained over the soils of the courtyard. For the 1-3 foot interval soils, Significant Risk of harm exists for residents, but not for construction workers (although it is close). For the 0-1 interval soils and the vault sands (SP-3), a Significant Risk of harm exists for both construction workers and residents. The principal drivers of the non-cancer risks are PCBs, dioxin (TCDD equivalence) and lead.

Risk of Non-Threshold (Carcinogenic) Health Effects: For each receptor group, the total cumulative ELCR is compared to MassDEP's cumulative cancer risk limit of 1E-05. ELCRs were calculated for resident, commercial worker and construction worker. Limits on future exposure to residents, entailing the maintenance of a protective barrier over soils and implementation of a soil management plan during future construction or utility work, were assumed. The results of the cancer risk assessments are summarized in Appendices C-1 to C-5 for construction workers and in Appendix C-6 for residents. A comparison of the cumulative ELCRs to the cancer risk limit is provided in Table C-11.

Based on these findings, No Significant cancer Risk of harm exists for construction workers for all exposure points/soil intervals, and exists for residents for all exposure point/soil intervals except for the 0-1 foot interval and the vault sands (SP-3). The principal driver of the cancer risk is PCBs, with significant contribution from dioxin (TCDD equivalence).

Comparison of Site Conditions to Applicable or Suitably Analogous Public Health Standards: No applicable or suitably analogous public health standards were identified for the Site.

Uncertainty Analysis

Uncertainty is inherent in the risk assessment process, which includes a variety of scientific judgments. In general, during the course of a risk characterization, conservative assumptions or decisions are made in order to minimize the possibility that uncertainty would result in a false indication of no significant risk of harm. Uncertainties specific to this risk assessment are provided below.

Site Characterization: Uncertainties relating to the adequacy of Site characterization, including the sampling plan and analytical data, always exist, but can be minimized with a carefully planned field investigation. In general, conservative assumptions were made throughout the risk characterization, to account for limitations in Site data.

No directly measured levels of particulate-bound OHM (dusts) in ambient air were obtained. It was not possible to obtain these data, because current site conditions are not consistent with the evaluated exposure pathway. Equations with conservative input values were used to provide estimates of OHM as dusts.

Assumptions concerning the frequency, duration, and magnitude of receptor exposures: Either means, 95th percentile upper confidence limits on the mean or mean concentrations were used to obtain estimates of EPCs. 95th Percentile upper confidence limits on the mean were used when significant data variability exists for a specific exposure point and media, or where a limited amount of data is available. Exposure factors were either provided in MassDEP's Construction Worker ShortForm or were generally consistent with those used in MassDEP's documentation for developing Method 1 Standards, or recommended by MassDEP in its *Guidance Document for Disposal Site Risk Characterization* and related Technical Updates. However, because a protective barrier is assumed to be present, some of the exposure factors for on-Site resident assumed exposure would not occur except during a six-month construction project.

Availability and accuracy of the toxicity data: The development of dose-response values and relative absorption factors has uncertainties dependent on the amount of quality toxicity data available for the chemical. However, dose-response values that were derived, recommended or provided by MassDEP were used in this risk characterization.

Risk Characterization Conclusions

Conclusions Regarding Risk of Harm to Human Health and Conditions for Notice of Activity and Use Limitation

Risk of harm to human health was characterized for the Site via a MCP Method 3 Human Health Risk Characterization. Assumptions limiting future activities or uses of the Site were considered during the course of the risk characterization.

The total cumulative HIs for all receptors were less than MCP's Method 3 non-cancer risk limit for the 3-6 and 3-11 foot intervals. The total cumulative HIs for one or both receptors were more than the MCP's Method 3 non-cancer risk limit for the 0-1 foot interval, 1-3 foot interval and vault soils (SP-3). Except for the 0-1 foot interval soils and the vault sands (SP-3) for residents, the total cumulative ELCR for all receptors, exposure points and soil intervals were less than the MCP's Method 3 cancer risk limit. These findings presume that a protective barrier is maintained over the soils of the courtyard.

Based on these findings the 0-1 foot interval soils, 1-3 foot interval soils and vault soils (SP-3) would need to be remediated to achieve No Significant Risk of harm. Assumptions were already made that the SP-1 and SP-2 stockpiles will be remediated, as well as the soils used to backfill the gasoline tank graves.

If the soils identified above are remediated, No Significant Risk of harm to human health will be achieved for the courtyard, assuming some limits on future activities and uses. Gardening of edible produce is presumed not to be conducted within the disposal site boundaries through Best Management Practices. A protective barrier is assumed to be maintained over the soils of the courtyard. This latter assumption will require the implementation of a Notice of AUL for the courtyard in order for the findings of the risk assessment to be valid. Requirements of the Notice of AUL will include: (1) periodic inspection and maintenance of the protective barrier over the soils; (2) during construction or utility repair projects, the use of a Soil Management Plan to properly manage soils; and (3) following the completion of the construction or utility repair project the placement of the soils at its original depth and reinstallation or repair of the protective barrier. If a clean utility corridor is installed to house live subsurface utility lines and structures, then a Soil Management Plan would not be needed during a utility repair project, but would still be needed for construction projects.

Soils slated for remediation that contain more than 50 mg/kg PCBs should be transported off-site to a facility that can accept high level PCBs. The remaining soils slated for remediation could be either sent to a low level PCB facility or could be placed in an on-Site soil repository, at a depth more than 3 feet below grade. Potential on-site soil repositories identified for the Site include a coal chute,

utility vault located in the northwest corner of the courtyard, four dry wells discovered in the western portion of the courtyard, and, following excavation, the FO-1 and FO-2 vault areas in the east portion of the courtyard. These areas would have separate Notice of AUL conditions, including: (1) physical separation from surrounding soils; (2) not allowing any excavation of these soils except by persons who are 40-hour HAZWOPER trained under OSHA and under the direction of an LSP; (3) either replacement of soils back into the repository or off-site transport of the soils following excavation; and (4) maintenance of the soil repositories.

The principal risk drivers for the human health risk characterization are PCB and, to a lesser extent, dioxin (TCDD equivalence) and lead. Site-specific cleanup standards could be derived prior to beginning clean up to help in evaluating whether to place specific soil volumes in repositories or to transport the soils off-Site. However, based on GEC's experience given the complex mixture of OHM present in the soils, a quick, volume-specific risk assessment using MassDEP's ShortForm or GEC's risk assessment workbook would provide greater flexibility.

Method 3 Risk Assessment for Chemicals in Soil - Construction Worker Shortform 2012 (sf12cw)

Index

Tab

EPCs	Table CW-1: Select chemicals and enter Exposure Point Concentrations (EPCs). Estimated risks are shown to the right.
C Eq	Table CW-2: Equations to calculate cancer risks
NC Eq	Table CW-3: Equations to calculate noncancer risks
Exp	Table CW-4: Definitions and exposure factors
Chem	Table CW-5: Chemical-specific data
Cyanide	Table CW-6: Cyanide Calculations

Spreadsheets designed by Andrew Friedmann, MassDEP

Questions and Comments may be addressed to:

Lydia Thompson

Massachusetts Department of Environmental Protection

Office of Research and Standards

One Winter Street

Boston, MA 02108 USA

Telephone: (617) 556-1165

Fax: (617) 556-1006

Email: Lydia.Thompson@state.ma.us

Construction Worker - Soil: Table CW-1
Exposure Point Concentration (EPC) and Risk
Based on Construction Worker 18-25 years of age

Courtyard: 0-1 Foot Interval (PCBs)
0-3 Foot Interval (Remainder)

ShortForm Version 10-12
Vlookup Version v0315

****Do not insert or delete any rows****

Click on empty cell below and select OHM using arrow.

ELCR (all chemicals) = 2.1E-06
HI (all chemicals) = **3.2E+00**

Oil or Hazardous	EPC	ELCR	ELCR	ELCR	ELCR		Subchronic				
Material (OHM)	(mg/kg)	ingestion	dermal	inhalation GI	inhalation pulmonary	ELCR _{total}	HQ _{ing}	HQ _{derm}	HQ _{inh-GI}	HQ _{inh}	HQ _{total}
POLYCHLORINATED BIPHENYLS (PCBs)	4.1E+01	7.2E-07	7.2E-07	1.9E-08	1.1E-09	1.5E-06	1.0E+00	1.0E+00	2.6E-02	7.6E-02	2.1E+00
ALIPHATICS C9 to C18	4.4E+01						5.4E-05	1.1E-04	1.4E-06	2.7E-06	1.7E-04
ALIPHATICS C19 to C36	1.8E+02						3.7E-05	7.4E-05	9.5E-07		1.1E-04
AROMATICS C11 to C22	3.0E+02						3.7E-04	1.2E-03	9.5E-06	2.2E-05	1.6E-03
ACENAPHTHENE	8.6E-01						1.6E-06	5.3E-06	4.1E-08	6.4E-08	7.0E-06
ACENAPHTHYLENE	2.3E-01						2.8E-07	9.5E-07	7.3E-09	1.7E-08	1.3E-06
ANTHRACENE	1.9E+00						7.0E-07	2.4E-06	1.8E-08	1.4E-07	3.2E-06
BENZO(a)ANTHRACENE	4.3E+00	8.3E-09	5.5E-09	2.1E-10	2.4E-10	1.4E-08	5.3E-06	3.6E-06	1.4E-07	3.2E-07	9.3E-06
BENZO(a)PYRENE	3.9E+00	7.5E-08	5.0E-08	1.9E-09	2.2E-09	1.3E-07	4.8E-06	3.2E-06	1.2E-07	2.9E-07	8.4E-06
BENZO(b)FLUORANTHENE	5.1E+00	9.8E-09	6.6E-09	2.5E-10	2.8E-10	1.7E-08	6.3E-06	4.2E-06	1.6E-07	3.8E-07	1.1E-05
BENZO(g,h,i)PERYLENE	2.2E+00						2.7E-06	9.1E-06	7.0E-08	1.6E-07	1.2E-05
BENZO(k)FLUORANTHENE	1.8E+00	3.5E-10	2.3E-10	9.0E-12	1.0E-11	6.0E-10	2.2E-06	1.5E-06	5.7E-08	1.3E-07	3.9E-06
CHRYSENE	4.8E+00	9.2E-10	6.2E-10	2.4E-11	2.7E-11	1.6E-09	5.9E-06	4.0E-06	1.5E-07	3.6E-07	1.0E-05
DIBENZO(a,h)ANTHRACENE	6.5E-01	1.2E-08	8.4E-09	3.2E-10	3.6E-10	2.2E-08	8.0E-07	5.4E-07	2.1E-08	4.8E-08	1.4E-06
FLUORANTHENE	9.9E+00						3.7E-05	1.2E-04	9.5E-07	7.4E-07	1.6E-04
FLUORENE	8.9E-01						8.2E-07	2.8E-06	2.1E-08	6.6E-08	3.7E-06
INDENO(1,2,3-cd)PYRENE	2.5E+00	4.8E-09	3.2E-09	1.2E-10	1.4E-10	8.3E-09	3.1E-06	2.1E-06	8.0E-08	1.9E-07	5.4E-06
METHYLNAPHTHALENE, 2-	3.3E-01						3.0E-05	1.0E-04	7.9E-07	2.5E-08	1.3E-04
NAPHTHALENE	7.5E-01						1.4E-06	4.7E-06	3.6E-08	9.3E-06	1.5E-05
PHENANTHRENE	7.9E+00						9.7E-06	3.3E-05	2.5E-07	5.9E-07	4.3E-05
PYRENE	9.6E+00						1.2E-05	4.0E-05	3.1E-07	7.2E-07	5.3E-05
BARIUM	1.1E+02						1.9E-03	1.9E-03	4.9E-05	8.0E-04	4.6E-03
BERYLLIUM	5.1E+00				3.2E-09	3.2E-09	1.3E-03	1.3E-03	3.3E-05	9.5E-03	1.2E-02
CHROMIUM(III)	3.6E+01						3.0E-05	3.0E-05	7.7E-07	4.5E-03	4.5E-03
LEAD	4.4E+02						3.6E-01	4.3E-02	9.3E-03	1.6E-02	4.3E-01
NICKEL	3.4E+01				4.3E-09	4.3E-09	2.1E-03	4.2E-03	5.4E-05	1.3E-03	7.6E-03
VANADIUM	3.7E+02						5.1E-02	5.1E-02	1.3E-03	1.4E-02	1.2E-01
ZINC	1.9E+02						7.7E-04	7.8E-04	2.0E-05	5.0E-03	6.6E-03
DICHLORODIPHENYLDICHLOROETHYLENE, P,P'- (DDI)	5.4E-02	1.6E-10	4.9E-11	4.2E-12	1.4E-12	2.2E-10	1.3E-04	4.0E-05	3.4E-06	1.1E-06	1.8E-04
DICHLORODIPHENYLTRICHLOROETHANE, P,P'- (DDT)	1.0E-01	3.0E-10	9.2E-11	7.9E-12	2.6E-12	4.1E-10	2.5E-04	7.6E-05	6.5E-06	2.1E-06	3.4E-04
DIELDRIN	1.1E-01	1.5E-08	1.5E-08	3.9E-10	1.3E-10	3.1E-08	2.7E-03	2.7E-03	6.9E-05	2.2E-05	5.4E-03
TCDD, 2,3,7,8- (equivalents)	1.4E-04	1.8E-07	1.8E-07	4.6E-09	1.2E-09	3.6E-07	2.4E-01	2.4E-01	6.2E-03	2.5E-03	4.9E-01

Construction Worker - Soil: Table CW-2

Equations to Calculate Cancer Risk for Construction Worker

Vlookup Version v0315

Cancer Risk from Ingestion

$$ELCR_{ing} = LADD_{ing} * CSF_{oral}$$

$$LADD_{ing} = \frac{EPC * IR * RAF_{c-ing} * EF * ED_{ing} * EP * C1}{BW * AP_{lifetime}}$$

Cancer Risk from Dermal Absorption

$$ELCR_{derm} = LADD_{derm} * CSF_{oral}$$

$$LADD_{derm} = \frac{EPC * SA * AF * RAF_{c-derm} * EF * ED_{derm} * EP * C1}{BW * AP_{lifetime}}$$

Cancer Risk from Particulate Inhalation - Gastrointestinal Absorption

$$ELCR_{inh-GI} = LADD_{inh-GI} * CSF_{oral}$$

$$LADD_{inh-GI} = \frac{EPC * RCAF_{inh-gi} * PM_{10} * VR_{work} * RAF_{c-ing} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{lifetime}}$$

Cancer Risk from Particulate Inhalation - Pulmonary Absorption

$$ELCR_{inh} = LADD_{inh} * CSF_{inhalation}$$

$$LADD = \frac{EPC * RCAF_{inh} * PM_{10} * VR_{work} * RAF_{c-inh} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{lifetime}}$$

Parameter	Value	Units
CSF	OHM-specific	(mg/kg-day) ⁻¹
LADD	age/OHM-specific	mg/kg-day
EPC	OHM-specific	mg/kg
IR	100	mg/day
RAF _{c-ing}	OHM-specific	dimensionless
RAF _{c-derm}	OHM-specific	dimensionless
RAF _{c-inh}	OHM-specific	dimensionless
EF	0.714	event/day
ED _{ing & derm}	1	day/event
ED _{inh}	0.333	day/event
EP	182	days
C1	1.0E-06	kg/mg
C2	1.0E-09	kg/μg
C3	1440	min/days
C4	1.0E-03	m ³ /L
BW	58.0	kg
AP _(lifetime)	25,550	days
VR _{work}	60	L/min
AF	0.29	mg/cm ²
SA	3473	cm ² /day
RCAF _{inh-gi}	1.5	dimensionless
RCAF _{inh}	0.5	dimensionless
PM ₁₀	60	μg/m ³

Construction Worker - Soil: Table CW-3 **Equations to Calculate Noncancer Risk for Construction Worker**

Vlookup Version v0315

Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD_{oral-subchronic}}$$

$$ADD_{ing} = \frac{EPC * IR * RAF_{nc-ing} * EF * ED_{ing} * EP * C1}{BW * AP_{noncancer}}$$

Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{derm}}{RfD_{oral-subchronic}}$$

$$ADD_{derm} = \frac{EPC * SA * AF * RAF_{nc-derm} * EF * ED_{dermal} * EP * C1}{BW * AP_{noncancer}}$$

Noncancer Risk from Particulate Inhalation - Gastrointestinal Absorption

$$HQ_{inh-GI} = \frac{ADD_{inh-GI}}{RfD_{oral-subchronic}}$$

$$ADD_{inh-GI} = \frac{EPC * RCAF_{inh-gi} * PM_{10} * VR_{work} * RAF_{nc-ing} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{noncancer}}$$

Noncancer Risk from Particulate Inhalation - Pulmonary Absorption

$$HQ_{inh} = \frac{ADD}{RfD_{inhalation-subchronic}}$$

$$ADD_{inh} = \frac{EPC_{soil} * RCAF_{inh} * PM_{10} * VR_{work} * RAF_{nc-inh} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{noncancer}}$$

Parameter	Value	Units
RfD	OHM-specific	mg/kg-day
ADD	OHM-specific	mg/kg-day
EPC	OHM-specific	mg/kg
IR	100	mg/day
RAF _{nc-ing}	OHM-specific	dimensionless
RAF _{nc-derm}	OHM-specific	dimensionless
RAF _{nc-inh}	OHM-specific	dimensionless
EF	0.714	event/day
ED _{ing & derm}	1	day/event
ED _{inh}	0.333	day/event
EP	182	days
C1	1.0E-06	kg/mg
C2	1.0E-09	kg/μg
C3	1440	min/days
C4	1.0E-03	m ³ /L
BW	58.0	kg
AP _{noncancer}	182	days
VR _{work}	60	L/min
AF	0.29	mg/cm ²
SA	3473	cm ² /day
RCAF _{inh-gi}	1.5	dimensionless
RCAF _{inh}	0.5	dimensionless
PM10	60	μg/m ³

Construction Worker - Soil: Table CW-4

Definitions and Exposure Factors

Vlookup Version v0315

Parameter	Value	Units	Notes
ELCR - Excess Lifetime Cancer Risk	chemical specific	dimensionless	Pathway specific (ing =ingestion, derm=dermal, inh=inhilation)
HI - Hazard Index	chemical specific	dimensionless	Pathway specific (ing =ingestion, derm=dermal, inh=inhilation)
CSF - Cancer Slope Factor	chemical specific	(mg/kg-day) ⁻¹	see Table CW-5.
RfD - Reference Dose	chemical specific	mg/kg-day	see Table CW-5.
LADD - Lifetime Average Daily Dose	chemical specific	mg/kg-day	Pathway specific. See Table CW-2.
ADD - Average Daily Dose	chemical specific	mg/kg-day	Pathway specific. See Table CW-3.
EPC - Exposure Point Concentration	chemical specific	mg/kg	see Table CW-1.
IR - Soil Ingestion Rate	100	mg/day	MADEP. 2002. Technical Update: Calculation of an Enhanced Soil Ingestion Rate. (http://www.mass.gov/dep/ors/orspubs.htm).
RAF _c - Relative Absorption Factor for Cancer Effects	chemical specific	dimensionless	Pathway specific - see Table CW-5.
RAF _{nc} - Relative Absorption Factor for Noncancer Effects	chemical specific	dimensionless	Pathway specific - see Table CW-5.
EF - Exposure Frequency	0.714	event/day	5 events (days) / 7 events (days) in a week; MADEP 1995 Guidance for Disposal Site Risk Characterization pg B-38.
ED _{ing,derm} - Exposure Duration for ingestion or dermal exposure	1	day/event	
ED _{inh} - Exposure Duration for inhalation exposure	0.333	day/event	Represents 8 hours / event.
EP - Exposure Period	182	days	6 months; MADEP 1995 Guidance for Disposal Site Risk Characterization.
BW - Body Weight	58.0	kg	U.S. EPA. 1997. Exposure Factors Handbook. Table 7-7, Females, ages 18 - 25.
AP _(lifetime) - Averaging Period for lifetime	25,550	days	Represents 70 years
AP _(noncancer) - Averaging Period for noncancer	182	days	6 months; MADEP 1995 Guidance for Disposal Site Risk Characterization.
AF - Adherence Factor	0.29	mg/cm ²	MA DEP. 2002 Technical Update: Weighted Skin-Soil Adherence Factors. (http://www.mass.gov/dep/ors/orspubs.htm)
VR _{work} - Ventilation Rate during work (heavy exertion)	60	L/min	Table B-4 MADEP 1995 Guidance for Disposal Site Risk Characterization.
SA - Surface Area	3473	cm ² /day	MADEP. 1995. Guidance for Disposal Site Risk Characterization. 50th percentile for females. Appendix Table B-2.
IFAF _{inh-gi} - Ingestion Fraction Adjustment Factor, gastrointestinal	1.5	dimensionless	MADEP 2007. Characterization of Risks Due to Inhalation of Particulates by Construction Workers
IFAF _{inh} - Inhalation Fraction Adjustment Factor, inhalation	0.5	dimensionless	MADEP 2002. Characterization of Risks Due to Inhalation of Particulates by Construction Workers
PM10 - Concentration of PM ₁₀	60	µg/m ³	MADEP 1995 Guidance for Disposal Site Risk Characterization pg B-11

Construction Worker - Soil: Table CW-5
Chemical-Specific Data

Vlookup Version v0315

Oil or Hazardous Material	Oral CSF (mg/kg-day) ⁻¹	RAF _{c-ing}	RAF _{c-derm}	RAF _{c-inh}	Inhalation CSF (mg/kg-day) ⁻¹	Subchronic Oral RfD mg/kg-day	Subchronic RAF _{nc-ing}	Subchronic RAF _{nc-derm}	Subchronic RAF _{nc-inh}	Subchronic Inhalation RfD
POLYCHLORINATED BIPHENYLS (PCBs)	2.0E+00	1	0.1	1	3.5E-01	5.0E-05	1	0.1	1	5.7E-06
ALIPHATICS C9 to C18						1.0E+00	1	0.2	1	1.7E-01
ALIPHATICS C19 to C36						6.0E+00	1	0.2		
AROMATICS C11 to C22						3.0E-01	0.3	0.1	1	1.4E-01
ACENAPHTHENE						2.0E-01	0.3	0.1	1	1.4E-01
ACENAPHTHYLENE						3.0E-01	0.3	0.1	1	1.4E-01
ANTHRACENE						1.0E+00	0.3	0.1	1	1.4E-01
BENZO(a)ANTHRACENE	7.3E-01	0.3	0.02	1	7.3E-01	3.0E-01	0.3	0.02	1	1.4E-01
BENZO(a)PYRENE	7.3E+00	0.3	0.02	1	7.3E+00	3.0E-01	0.3	0.02	1	1.4E-01
BENZO(b)FLUORANTHENE	7.3E-01	0.3	0.02	1	7.3E-01	3.0E-01	0.3	0.02	1	1.4E-01
BENZO(g,h,i)PERYLENE						3.0E-01	0.3	0.1	1	1.4E-01
BENZO(k)FLUORANTHENE	7.3E-02	0.3	0.02	1	7.3E-02	3.0E-01	0.3	0.02	1	1.4E-01
CHRYSENE	7.3E-02	0.3	0.02	1	7.3E-02	3.0E-01	0.3	0.02	1	1.4E-01
DIBENZO(a,h)ANTHRACENE	7.3E+00	0.3	0.02	1	7.3E+00	3.0E-01	0.3	0.02	1	1.4E-01
FLUORANTHENE						1.0E-01	0.3	0.1	1	1.4E-01
FLUORENE						4.0E-01	0.3	0.1	1	1.4E-01
INDENO(1,2,3-cd)PYRENE	7.3E-01	0.3	0.02	1	7.3E-01	3.0E-01	0.3	0.02	1	1.4E-01
METHYLNAPHTHALENE, 2-						4.0E-03	0.3	0.1	1	1.4E-01
NAPHTHALENE						2.0E-01	0.3	0.1	1	8.6E-04
PHENANTHRENE						3.0E-01	0.3	0.1	1	1.4E-01
PYRENE						3.0E-01	0.3	0.1	1	1.4E-01
BARIUM						7.0E-02	1	0.1	1	1.4E-03
BERYLLIUM					8.4E+00	5.0E-03	1	0.1	1	5.7E-06
CHROMIUM(III)						1.5E+00	1	0.1	1	8.6E-05
LEAD						7.5E-04	0.5	0.006	1	2.9E-04
NICKEL					1.7E+00	2.0E-02	1	0.2	1	2.9E-04
VANADIUM						9.0E-03	1	0.1	1	2.9E-04
ZINC						3.0E-01	1	0.1	1	4.0E-04

Method 3 Risk Assessment for Chemicals in Soil - Construction Worker Shortform 2012 (sf12cw)

Index

Tab

EPCs	Table CW-1: Select chemicals and enter Exposure Point Concentrations (EPCs). Estimated risks are shown to the right.
C Eq	Table CW-2: Equations to calculate cancer risks
NC Eq	Table CW-3: Equations to calculate noncancer risks
Exp	Table CW-4: Definitions and exposure factors
Chem	Table CW-5: Chemical-specific data
Cyanide	Table CW-6: Cyanide Calculations

Spreadsheets designed by Andrew Friedmann, MassDEP

Questions and Comments may be addressed to:

Lydia Thompson

Massachusetts Department of Environmental Protection

Office of Research and Standards

One Winter Street

Boston, MA 02108 USA

Telephone: (617) 556-1165

Fax: (617) 556-1006

Email: Lydia.Thompson@state.ma.us

Construction Worker - Soil: Table CW-1
Exposure Point Concentration (EPC) and Risk
Based on Construction Worker 18-25 years of age

Courtyard: 1-3 Foot Interval (PCBs)
0-3 Foot Interval (Remainder)

ShortForm Version 10-12
Vlookup Version v0315

****Do not insert or delete any rows****

Click on empty cell below and select OHM using arrow.

ELCR (all chemicals) = 5.6E-07
HI (all chemicals) = 1.0E+00

Oil or Hazardous	EPC	ELCR	ELCR	ELCR	ELCR		Subchronic				
Material (OHM)	(mg/kg)	ingestion	dermal	inhalation GI	inhalation pulmonary	ELCR _{total}	HQ _{ing}	HQ _{derm}	HQ _{inh-GI}	HQ _{inh}	HQ _{total}
POLYCHLORINATED BIPHENYLS (PCBs)	7.6E+00	1.3E-07	1.3E-07	3.5E-09	2.0E-10	2.7E-07	1.9E-01	1.9E-01	4.9E-03	1.4E-02	3.9E-01
ALIPHATICS C9 to C18	4.4E+01						5.4E-05	1.1E-04	1.4E-06	2.7E-06	1.7E-04
ALIPHATICS C19 to C36	1.8E+02						3.7E-05	7.4E-05	9.5E-07		1.1E-04
AROMATICS C11 to C22	3.0E+02						3.7E-04	1.2E-03	9.5E-06	2.2E-05	1.6E-03
ACENAPHTHENE	8.6E-01						1.6E-06	5.3E-06	4.1E-08	6.4E-08	7.0E-06
ACENAPHTHYLENE	2.3E-01						2.8E-07	9.5E-07	7.3E-09	1.7E-08	1.3E-06
ANTHRACENE	1.9E+00						7.0E-07	2.4E-06	1.8E-08	1.4E-07	3.2E-06
BENZO(a)ANTHRACENE	4.3E+00	8.3E-09	5.5E-09	2.1E-10	2.4E-10	1.4E-08	5.3E-06	3.6E-06	1.4E-07	3.2E-07	9.3E-06
BENZO(a)PYRENE	3.9E+00	7.5E-08	5.0E-08	1.9E-09	2.2E-09	1.3E-07	4.8E-06	3.2E-06	1.2E-07	2.9E-07	8.4E-06
BENZO(b)FLUORANTHENE	5.1E+00	9.8E-09	6.6E-09	2.5E-10	2.8E-10	1.7E-08	6.3E-06	4.2E-06	1.6E-07	3.8E-07	1.1E-05
BENZO(g,h,i)PERYLENE	2.2E+00						2.7E-06	9.1E-06	7.0E-08	1.6E-07	1.2E-05
BENZO(k)FLUORANTHENE	1.8E+00	3.5E-10	2.3E-10	9.0E-12	1.0E-11	6.0E-10	2.2E-06	1.5E-06	5.7E-08	1.3E-07	3.9E-06
CHRYSENE	4.8E+00	9.2E-10	6.2E-10	2.4E-11	2.7E-11	1.6E-09	5.9E-06	4.0E-06	1.5E-07	3.6E-07	1.0E-05
DIBENZO(a,h)ANTHRACENE	6.5E-01	1.2E-08	8.4E-09	3.2E-10	3.6E-10	2.2E-08	8.0E-07	5.4E-07	2.1E-08	4.8E-08	1.4E-06
FLUORANTHENE	9.9E+00						3.7E-05	1.2E-04	9.5E-07	7.4E-07	1.6E-04
FLUORENE	8.9E-01						8.2E-07	2.8E-06	2.1E-08	6.6E-08	3.7E-06
INDENO(1,2,3-cd)PYRENE	2.5E+00	4.8E-09	3.2E-09	1.2E-10	1.4E-10	8.3E-09	3.1E-06	2.1E-06	8.0E-08	1.9E-07	5.4E-06
METHYLNAPHTHALENE, 2-	3.3E-01						3.0E-05	1.0E-04	7.9E-07	2.5E-08	1.3E-04
NAPHTHALENE	7.5E-01						1.4E-06	4.7E-06	3.6E-08	9.3E-06	1.5E-05
PHENANTHRENE	7.9E+00						9.7E-06	3.3E-05	2.5E-07	5.9E-07	4.3E-05
PYRENE	9.6E+00						1.2E-05	4.0E-05	3.1E-07	7.2E-07	5.3E-05
BARIUM	9.2E+01						1.6E-03	1.6E-03	4.2E-05	6.9E-04	4.0E-03
BERYLLIUM	9.2E+00				5.9E-09	5.9E-09	2.3E-03	2.3E-03	5.9E-05	1.7E-02	2.2E-02
CHROMIUM(III)	3.7E+01						3.0E-05	3.1E-05	7.9E-07	4.6E-03	4.7E-03
LEAD	3.7E+02						3.0E-01	3.6E-02	7.8E-03	1.4E-02	3.6E-01
NICKEL	4.0E+01				5.1E-09	5.1E-09	2.5E-03	5.0E-03	6.4E-05	1.5E-03	9.0E-03
VANADIUM	4.4E+02						6.1E-02	6.1E-02	1.6E-03	1.6E-02	1.4E-01
ZINC	1.8E+02						7.2E-04	7.2E-04	1.9E-05	4.7E-03	6.1E-03
DICHLORODIPHENYLDICHLOROETHYLENE, P,P'- (DDI)	4.7E-02	1.4E-10	4.2E-11	3.6E-12	1.2E-12	1.9E-10	1.2E-04	3.5E-05	3.0E-06	9.7E-07	1.5E-04
DICHLORODIPHENYLTRICHLOROETHANE, P,P'- (DDT)	6.8E-02	2.0E-10	6.1E-11	5.3E-12	1.7E-12	2.7E-10	1.7E-04	5.1E-05	4.3E-06	1.4E-06	2.2E-04
DIELDRIN	4.7E-02	6.6E-09	6.6E-09	1.7E-10	5.7E-11	1.3E-08	1.2E-03	1.2E-03	3.0E-05	9.7E-06	2.4E-03
TCDD, 2,3,7,8- (equivalents)	2.5E-05	3.3E-08	3.3E-08	8.6E-10	2.2E-10	6.7E-08	4.4E-02	4.4E-02	1.1E-03	4.7E-04	9.0E-02

Construction Worker - Soil: Table CW-2

Equations to Calculate Cancer Risk for Construction Worker

Vlookup Version v0315

Cancer Risk from Ingestion

$$ELCR_{ing} = LADD_{ing} * CSF_{oral}$$

$$LADD_{ing} = \frac{EPC * IR * RAF_{c-ing} * EF * ED_{ing} * EP * C1}{BW * AP_{lifetime}}$$

Cancer Risk from Dermal Absorption

$$ELCR_{derm} = LADD_{derm} * CSF_{oral}$$

$$LADD_{derm} = \frac{EPC * SA * AF * RAF_{c-derm} * EF * ED_{derm} * EP * C1}{BW * AP_{lifetime}}$$

Cancer Risk from Particulate Inhalation - Gastrointestinal Absorption

$$ELCR_{inh-GI} = LADD_{inh-GI} * CSF_{oral}$$

$$LADD_{inh-GI} = \frac{EPC * RCAF_{inh-gi} * PM_{10} * VR_{work} * RAF_{c-ing} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{lifetime}}$$

Cancer Risk from Particulate Inhalation - Pulmonary Absorption

$$ELCR_{inh} = LADD_{inh} * CSF_{inhalation}$$

$$LADD = \frac{EPC * RCAF_{inh} * PM_{10} * VR_{work} * RAF_{c-inh} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{lifetime}}$$

Parameter	Value	Units
CSF	OHM-specific	(mg/kg-day) ⁻¹
LADD	age/OHM-specific	mg/kg-day
EPC	OHM-specific	mg/kg
IR	100	mg/day
RAF _{c-ing}	OHM-specific	dimensionless
RAF _{c-derm}	OHM-specific	dimensionless
RAF _{c-inh}	OHM-specific	dimensionless
EF	0.714	event/day
ED _{ing & derm}	1	day/event
ED _{inh}	0.333	day/event
EP	182	days
C1	1.0E-06	kg/mg
C2	1.0E-09	kg/μg
C3	1440	min/days
C4	1.0E-03	m ³ /L
BW	58.0	kg
AP _(lifetime)	25,550	days
VR _{work}	60	L/min
AF	0.29	mg/cm ²
SA	3473	cm ² /day
RCAF _{inh-gi}	1.5	dimensionless
RCAF _{inh}	0.5	dimensionless
PM ₁₀	60	μg/m ³

Construction Worker - Soil: Table CW-3
Equations to Calculate Noncancer Risk for Construction Worker

Vlookup Version v0315

Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD_{oral-subchronic}}$$

$$ADD_{ing} = \frac{EPC * IR * RAF_{nc-ing} * EF * ED_{ing} * EP * C1}{BW * AP_{noncancer}}$$

Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{derm}}{RfD_{oral-subchronic}}$$

$$ADD_{derm} = \frac{EPC * SA * AF * RAF_{nc-derm} * EF * ED_{dermal} * EP * C1}{BW * AP_{noncancer}}$$

Noncancer Risk from Particulate Inhalation - Gastrointestinal Absorption

$$HQ_{inh-GI} = \frac{ADD_{inh-GI}}{RfD_{oral-subchronic}}$$

$$ADD_{inh-GI} = \frac{EPC * RCAF_{inh-gi} * PM_{10} * VR_{work} * RAF_{nc-ing} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{noncancer}}$$

Noncancer Risk from Particulate Inhalation - Pulmonary Absorption

$$HQ_{inh} = \frac{ADD}{RfD_{inhalation-subchronic}}$$

$$ADD_{inh} = \frac{EPC_{soil} * RCAF_{inh} * PM_{10} * VR_{work} * RAF_{nc-inh} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{noncancer}}$$

Parameter	Value	Units
RfD	OHM-specific	mg/kg-day
ADD	OHM-specific	mg/kg-day
EPC	OHM-specific	mg/kg
IR	100	mg/day
RAF _{nc-ing}	OHM-specific	dimensionless
RAF _{nc-derm}	OHM-specific	dimensionless
RAF _{nc-inh}	OHM-specific	dimensionless
EF	0.714	event/day
ED _{ing & derm}	1	day/event
ED _{inh}	0.333	day/event
EP	182	days
C1	1.0E-06	kg/mg
C2	1.0E-09	kg/μg
C3	1440	min/days
C4	1.0E-03	m ³ /L
BW	58.0	kg
AP _{noncancer}	182	days
VR _{work}	60	L/min
AF	0.29	mg/cm ²
SA	3473	cm ² /day
RCAF _{inh-gi}	1.5	dimensionless
RCAF _{inh}	0.5	dimensionless
PM10	60	μg/m ³

Construction Worker - Soil: Table CW-4

Definitions and Exposure Factors

Vlookup Version v0315

Parameter	Value	Units	Notes
ELCR - Excess Lifetime Cancer Risk	chemical specific	dimensionless	Pathway specific (ing =ingestion, derm=dermal, inh=inhilation)
HI - Hazard Index	chemical specific	dimensionless	Pathway specific (ing =ingestion, derm=dermal, inh=inhilation)
CSF - Cancer Slope Factor	chemical specific	(mg/kg-day) ⁻¹	see Table CW-5.
RfD - Reference Dose	chemical specific	mg/kg-day	see Table CW-5.
LADD - Lifetime Average Daily Dose	chemical specific	mg/kg-day	Pathway specific. See Table CW-2.
ADD - Average Daily Dose	chemical specific	mg/kg-day	Pathway specific. See Table CW-3.
EPC - Exposure Point Concentration	chemical specific	mg/kg	see Table CW-1.
IR - Soil Ingestion Rate	100	mg/day	MADEP. 2002. Technical Update: Calculation of an Enhanced Soil Ingestion Rate. (http://www.mass.gov/dep/ors/orspubs.htm).
RAF _c - Relative Absorption Factor for Cancer Effects	chemical specific	dimensionless	Pathway specific - see Table CW-5.
RAF _{nc} - Relative Absorption Factor for Noncancer Effects	chemical specific	dimensionless	Pathway specific - see Table CW-5.
EF - Exposure Frequency	0.714	event/day	5 events (days) / 7 events (days) in a week; MADEP 1995 Guidance for Disposal Site Risk Characterization pg B-38.
ED _{ing,derm} - Exposure Duration for ingestion or dermal exposure	1	day/event	
ED _{inh} - Exposure Duration for inhalation exposure	0.333	day/event	Represents 8 hours / event.
EP - Exposure Period	182	days	6 months; MADEP 1995 Guidance for Disposal Site Risk Characterization.
BW - Body Weight	58.0	kg	U.S. EPA. 1997. Exposure Factors Handbook. Table 7-7, Females, ages 18 - 25.
AP _(lifetime) - Averaging Period for lifetime	25,550	days	Represents 70 years
AP _(noncancer) - Averaging Period for noncancer	182	days	6 months; MADEP 1995 Guidance for Disposal Site Risk Characterization.
AF - Adherence Factor	0.29	mg/cm ²	MA DEP. 2002 Technical Update: Weighted Skin-Soil Adherence Factors. (http://www.mass.gov/dep/ors/orspubs.htm)
VR _{work} - Ventilation Rate during work (heavy exertion)	60	L/min	Table B-4 MADEP 1995 Guidance for Disposal Site Risk Characterization.
SA - Surface Area	3473	cm ² /day	MADEP. 1995. Guidance for Disposal Site Risk Characterization. 50th percentile for females. Appendix Table B-2.
IFAF _{inh-gi} - Ingestion Fraction Adjustment Factor, gastrointestinal	1.5	dimensionless	MADEP 2007. Characterization of Risks Due to Inhalation of Particulates by Construction Workers
IFAF _{inh} - Inhalation Fraction Adjustment Factor, inhalation	0.5	dimensionless	MADEP 2002. Characterization of Risks Due to Inhalation of Particulates by Construction Workers
PM10 - Concentration of PM ₁₀	60	µg/m ³	MADEP 1995 Guidance for Disposal Site Risk Characterization pg B-11

Construction Worker - Soil: Table CW-5
Chemical-Specific Data

Vlookup Version v0315

Oil or Hazardous Material	Oral CSF (mg/kg-day) ⁻¹	RAF _{c-ing}	RAF _{c-derm}	RAF _{c-inh}	Inhalation CSF (mg/kg-day) ⁻¹	Subchronic Oral RfD mg/kg-day	Subchronic RAF _{nc-ing}	Subchronic RAF _{nc-derm}	Subchronic RAF _{nc-inh}	Subchronic Inhalation RfD
POLYCHLORINATED BIPHENYLS (PCBs)	2.0E+00	1	0.1	1	3.5E-01	5.0E-05	1	0.1	1	5.7E-06
ALIPHATICS C9 to C18						1.0E+00	1	0.2	1	1.7E-01
ALIPHATICS C19 to C36						6.0E+00	1	0.2		
AROMATICS C11 to C22						3.0E-01	0.3	0.1	1	1.4E-01
ACENAPHTHENE						2.0E-01	0.3	0.1	1	1.4E-01
ACENAPHTHYLENE						3.0E-01	0.3	0.1	1	1.4E-01
ANTHRACENE						1.0E+00	0.3	0.1	1	1.4E-01
BENZO(a)ANTHRACENE	7.3E-01	0.3	0.02	1	7.3E-01	3.0E-01	0.3	0.02	1	1.4E-01
BENZO(a)PYRENE	7.3E+00	0.3	0.02	1	7.3E+00	3.0E-01	0.3	0.02	1	1.4E-01
BENZO(b)FLUORANTHENE	7.3E-01	0.3	0.02	1	7.3E-01	3.0E-01	0.3	0.02	1	1.4E-01
BENZO(g,h,i)PERYLENE						3.0E-01	0.3	0.1	1	1.4E-01
BENZO(k)FLUORANTHENE	7.3E-02	0.3	0.02	1	7.3E-02	3.0E-01	0.3	0.02	1	1.4E-01
CHRYSENE	7.3E-02	0.3	0.02	1	7.3E-02	3.0E-01	0.3	0.02	1	1.4E-01
DIBENZO(a,h)ANTHRACENE	7.3E+00	0.3	0.02	1	7.3E+00	3.0E-01	0.3	0.02	1	1.4E-01
FLUORANTHENE						1.0E-01	0.3	0.1	1	1.4E-01
FLUORENE						4.0E-01	0.3	0.1	1	1.4E-01
INDENO(1,2,3-cd)PYRENE	7.3E-01	0.3	0.02	1	7.3E-01	3.0E-01	0.3	0.02	1	1.4E-01
METHYLNAPHTHALENE, 2-						4.0E-03	0.3	0.1	1	1.4E-01
NAPHTHALENE						2.0E-01	0.3	0.1	1	8.6E-04
PHENANTHRENE						3.0E-01	0.3	0.1	1	1.4E-01
PYRENE						3.0E-01	0.3	0.1	1	1.4E-01
BARIUM						7.0E-02	1	0.1	1	1.4E-03
BERYLLIUM					8.4E+00	5.0E-03	1	0.1	1	5.7E-06
CHROMIUM(III)						1.5E+00	1	0.1	1	8.6E-05
LEAD						7.5E-04	0.5	0.006	1	2.9E-04
NICKEL					1.7E+00	2.0E-02	1	0.2	1	2.9E-04
VANADIUM						9.0E-03	1	0.1	1	2.9E-04
ZINC						3.0E-01	1	0.1	1	4.0E-04

Method 3 Risk Assessment for Chemicals in Soil - Construction Worker Shortform 2012 (sf12cw)

Index

Tab

EPCs	Table CW-1: Select chemicals and enter Exposure Point Concentrations (EPCs). Estimated risks are shown to the right.
C Eq	Table CW-2: Equations to calculate cancer risks
NC Eq	Table CW-3: Equations to calculate noncancer risks
Exp	Table CW-4: Definitions and exposure factors
Chem	Table CW-5: Chemical-specific data
Cyanide	Table CW-6: Cyanide Calculations

Spreadsheets designed by Andrew Friedmann, MassDEP

Questions and Comments may be addressed to:

Lydia Thompson

Massachusetts Department of Environmental Protection

Office of Research and Standards

One Winter Street

Boston, MA 02108 USA

Telephone: (617) 556-1165

Fax: (617) 556-1006

Email: Lydia.Thompson@state.ma.us

Construction Worker - Soil: Table CW-1
Exposure Point Concentration (EPC) and Risk
Based on Construction Worker 18-25 years of age

Courtyard: 3-6 Foot Interval (PCBs and Remainder)

ShortForm Version 10-12
Vlookup Version v0315

****Do not insert or delete any rows****

Click on empty cell below and select OHM using arrow.

ELCR (all chemicals) = 1.8E-07

HI (all chemicals) = 2.9E-01

Oil or Hazardous	EPC	ELCR	ELCR	ELCR	ELCR		Subchronic				
Material (OHM)	(mg/kg)	ingestion	dermal	inhalation GI	inhalation pulmonary	ELCR _{total}	HQ _{ing}	HQ _{derm}	HQ _{inh-GI}	HQ _{inh}	HQ _{total}
POLYCHLORINATED BIPHENYLS (PCBs)	1.9E+00	3.3E-08	3.4E-08	8.6E-10	5.0E-11	6.8E-08	4.7E-02	4.7E-02	1.2E-03	3.5E-03	9.9E-02
ALIPHATICS C9 to C18	1.2E+01						1.5E-05	3.0E-05	3.8E-07	7.4E-07	4.6E-05
ALIPHATICS C19 to C36	4.7E+01						9.6E-06	1.9E-05	2.5E-07		2.9E-05
AROMATICS C11 to C22	9.8E+01						1.2E-04	4.1E-04	3.1E-06	7.3E-06	5.4E-04
ACENAPHTHENE	3.8E-01						7.0E-07	2.4E-06	1.8E-08	2.8E-08	3.1E-06
ACENAPHTHYLENE	8.4E-02						1.0E-07	3.5E-07	2.7E-09	6.3E-09	4.6E-07
ANTHRACENE	8.4E-01						3.1E-07	1.0E-06	8.0E-09	6.3E-08	1.4E-06
BENZO(a)ANTHRACENE	1.8E+00	3.5E-09	2.3E-09	9.0E-11	1.0E-10	6.0E-09	2.2E-06	1.5E-06	5.7E-08	1.3E-07	3.9E-06
BENZO(a)PYRENE	1.6E+00	3.1E-08	2.1E-08	8.0E-10	8.9E-10	5.3E-08	2.0E-06	1.3E-06	5.1E-08	1.2E-07	3.5E-06
BENZO(b)FLUORANTHENE	2.2E+00	4.2E-09	2.8E-09	1.1E-10	1.2E-10	7.3E-09	2.7E-06	1.8E-06	7.0E-08	1.6E-07	4.8E-06
BENZO(g,h,i)PERYLENE	9.1E-01						1.1E-06	3.8E-06	2.9E-08	6.8E-08	5.0E-06
BENZO(k)FLUORANTHENE	8.3E-01	1.6E-10	1.1E-10	4.1E-12	4.6E-12	2.8E-10	1.0E-06	6.9E-07	2.6E-08	6.2E-08	1.8E-06
CHRYSENE	1.9E+00	3.7E-10	2.5E-10	9.5E-12	1.1E-11	6.3E-10	2.3E-06	1.6E-06	6.1E-08	1.4E-07	4.1E-06
DIBENZO(a,h)ANTHRACENE	2.5E-01	4.8E-09	3.2E-09	1.2E-10	1.4E-10	8.3E-09	3.1E-07	2.1E-07	8.0E-09	1.9E-08	5.4E-07
FLUORANTHENE	4.0E+00						1.5E-05	5.0E-05	3.8E-07	3.0E-07	6.5E-05
FLUORENE	4.1E-01						3.8E-07	1.3E-06	9.8E-09	3.1E-08	1.7E-06
INDENO(1,2,3-cd)PYRENE	9.7E-01	1.9E-09	1.3E-09	4.8E-11	5.4E-11	3.2E-09	1.2E-06	8.0E-07	3.1E-08	7.2E-08	2.1E-06
METHYLNAPHTHALENE, 2-	1.3E-01						1.2E-05	4.0E-05	3.1E-07	9.7E-09	5.3E-05
NAPHTHALENE	1.8E-01						3.3E-07	1.1E-06	8.6E-09	2.2E-06	3.7E-06
PHENANTHRENE	3.4E+00						4.2E-06	1.4E-05	1.1E-07	2.5E-07	1.9E-05
PYRENE	3.7E+00						4.6E-06	1.5E-05	1.2E-07	2.8E-07	2.0E-05
BARIUM	4.9E+01						8.6E-04	8.7E-04	2.2E-05	3.6E-04	2.1E-03
BERYLLIUM	1.9E+00				1.2E-09	1.2E-09	4.7E-04	4.7E-04	1.2E-05	3.5E-03	4.5E-03
CHROMIUM(III)	1.7E+01						1.4E-05	1.4E-05	3.6E-07	2.1E-03	2.1E-03
LEAD	1.1E+02						8.6E-02	1.0E-02	2.2E-03	3.9E-03	1.0E-01
NICKEL	2.4E+01				3.1E-09	3.1E-09	1.5E-03	3.0E-03	3.8E-05	8.9E-04	5.4E-03
VANADIUM	1.5E+02						2.1E-02	2.1E-02	5.4E-04	5.6E-03	4.8E-02
ZINC	9.4E+01						3.9E-04	3.9E-04	1.0E-05	2.5E-03	3.3E-03
CHLORDANE	1.3E-01	4.0E-10	1.6E-10	1.0E-11	3.4E-12	5.7E-10	3.2E-04	1.3E-04	8.3E-06	6.9E-07	4.6E-04
DICHLORODIPHENYLTRICHLOROETHANE, P,P'- (DDT)	3.7E-02	1.1E-10	3.3E-11	2.9E-12	9.5E-13	1.5E-10	9.1E-05	2.8E-05	2.4E-06	7.7E-07	1.2E-04
DIELDRIN	3.2E-02	4.5E-09	4.5E-09	1.2E-10	3.9E-11	9.2E-09	7.9E-04	7.9E-04	2.0E-05	6.6E-06	1.6E-03
BENZENE	5.3E-02	2.6E-11	7.7E-12	6.6E-13	1.1E-13	3.4E-11	6.5E-06	2.0E-06	1.7E-07	2.0E-07	8.9E-06

Construction Worker - Soil: Table CW-2

Equations to Calculate Cancer Risk for Construction Worker

Vlookup Version v0315

Cancer Risk from Ingestion

$$ELCR_{ing} = LADD_{ing} * CSF_{oral}$$

$$LADD_{ing} = \frac{EPC * IR * RAF_{c-ing} * EF * ED_{ing} * EP * C1}{BW * AP_{lifetime}}$$

Cancer Risk from Dermal Absorption

$$ELCR_{derm} = LADD_{derm} * CSF_{oral}$$

$$LADD_{derm} = \frac{EPC * SA * AF * RAF_{c-derm} * EF * ED_{derm} * EP * C1}{BW * AP_{lifetime}}$$

Cancer Risk from Particulate Inhalation - Gastrointestinal Absorption

$$ELCR_{inh-GI} = LADD_{inh-GI} * CSF_{oral}$$

$$LADD_{inh-GI} = \frac{EPC * RCAF_{inh-gi} * PM_{10} * VR_{work} * RAF_{c-ing} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{lifetime}}$$

Cancer Risk from Particulate Inhalation - Pulmonary Absorption

$$ELCR_{inh} = LADD_{inh} * CSF_{inhalation}$$

$$LADD = \frac{EPC * RCAF_{inh} * PM_{10} * VR_{work} * RAF_{c-inh} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{lifetime}}$$

Parameter	Value	Units
CSF	OHM-specific	(mg/kg-day) ⁻¹
LADD	age/OHM-specific	mg/kg-day
EPC	OHM-specific	mg/kg
IR	100	mg/day
RAF _{c-ing}	OHM-specific	dimensionless
RAF _{c-derm}	OHM-specific	dimensionless
RAF _{c-inh}	OHM-specific	dimensionless
EF	0.714	event/day
ED _{ing & derm}	1	day/event
ED _{inh}	0.333	day/event
EP	182	days
C1	1.0E-06	kg/mg
C2	1.0E-09	kg/μg
C3	1440	min/days
C4	1.0E-03	m ³ /L
BW	58.0	kg
AP _(lifetime)	25,550	days
VR _{work}	60	L/min
AF	0.29	mg/cm ²
SA	3473	cm ² /day
RCAF _{inh-gi}	1.5	dimensionless
RCAF _{inh}	0.5	dimensionless
PM ₁₀	60	μg/m ³

Construction Worker - Soil: Table CW-3
Equations to Calculate Noncancer Risk for Construction Worker

Vlookup Version v0315

Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD_{oral-subchronic}}$$

$$ADD_{ing} = \frac{EPC * IR * RAF_{nc-ing} * EF * ED_{ing} * EP * C1}{BW * AP_{noncancer}}$$

Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{derm}}{RfD_{oral-subchronic}}$$

$$ADD_{derm} = \frac{EPC * SA * AF * RAF_{nc-derm} * EF * ED_{dermal} * EP * C1}{BW * AP_{noncancer}}$$

Noncancer Risk from Particulate Inhalation - Gastrointestinal Absorption

$$HQ_{inh-GI} = \frac{ADD_{inh-GI}}{RfD_{oral-subchronic}}$$

$$ADD_{inh-GI} = \frac{EPC * RCAF_{inh-gi} * PM_{10} * VR_{work} * RAF_{nc-ing} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{noncancer}}$$

Noncancer Risk from Particulate Inhalation - Pulmonary Absorption

$$HQ_{inh} = \frac{ADD}{RfD_{inhalation-subchronic}}$$

$$ADD_{inh} = \frac{EPC_{soil} * RCAF_{inh} * PM_{10} * VR_{work} * RAF_{nc-inh} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{noncancer}}$$

Parameter	Value	Units
RfD	OHM-specific	mg/kg-day
ADD	OHM-specific	mg/kg-day
EPC	OHM-specific	mg/kg
IR	100	mg/day
RAF _{nc-ing}	OHM-specific	dimensionless
RAF _{nc-derm}	OHM-specific	dimensionless
RAF _{nc-inh}	OHM-specific	dimensionless
EF	0.714	event/day
ED _{ing & derm}	1	day/event
ED _{inh}	0.333	day/event
EP	182	days
C1	1.0E-06	kg/mg
C2	1.0E-09	kg/μg
C3	1440	min/days
C4	1.0E-03	m ³ /L
BW	58.0	kg
AP _{noncancer}	182	days
VR _{work}	60	L/min
AF	0.29	mg/cm ²
SA	3473	cm ² /day
RCAF _{inh-gi}	1.5	dimensionless
RCAF _{inh}	0.5	dimensionless
PM10	60	μg/m ³

Construction Worker - Soil: Table CW-4

Definitions and Exposure Factors

Vlookup Version v0315

Parameter	Value	Units	Notes
ELCR - Excess Lifetime Cancer Risk	chemical specific	dimensionless	Pathway specific (ing =ingestion, derm=dermal, inh=inhilation)
HI - Hazard Index	chemical specific	dimensionless	Pathway specific (ing =ingestion, derm=dermal, inh=inhilation)
CSF - Cancer Slope Factor	chemical specific	(mg/kg-day) ⁻¹	see Table CW-5.
RfD - Reference Dose	chemical specific	mg/kg-day	see Table CW-5.
LADD - Lifetime Average Daily Dose	chemical specific	mg/kg-day	Pathway specific. See Table CW-2.
ADD - Average Daily Dose	chemical specific	mg/kg-day	Pathway specific. See Table CW-3.
EPC - Exposure Point Concentration	chemical specific	mg/kg	see Table CW-1.
IR - Soil Ingestion Rate	100	mg/day	MADEP. 2002. Technical Update: Calculation of an Enhanced Soil Ingestion Rate. (http://www.mass.gov/dep/ors/orspubs.htm).
RAF _c - Relative Absorption Factor for Cancer Effects	chemical specific	dimensionless	Pathway specific - see Table CW-5.
RAF _{nc} - Relative Absorption Factor for Noncancer Effects	chemical specific	dimensionless	Pathway specific - see Table CW-5.
EF - Exposure Frequency	0.714	event/day	5 events (days) / 7 events (days) in a week; MADEP 1995 Guidance for Disposal Site Risk Characterization pg B-38.
ED _{ing,derm} - Exposure Duration for ingestion or dermal exposure	1	day/event	
ED _{inh} - Exposure Duration for inhalation exposure	0.333	day/event	Represents 8 hours / event.
EP - Exposure Period	182	days	6 months; MADEP 1995 Guidance for Disposal Site Risk Characterization.
BW - Body Weight	58.0	kg	U.S. EPA. 1997. Exposure Factors Handbook. Table 7-7, Females, ages 18 - 25.
AP _(lifetime) - Averaging Period for lifetime	25,550	days	Represents 70 years
AP _(noncancer) - Averaging Period for noncancer	182	days	6 months; MADEP 1995 Guidance for Disposal Site Risk Characterization.
AF - Adherence Factor	0.29	mg/cm ²	MA DEP. 2002 Technical Update: Weighted Skin-Soil Adherence Factors. (http://www.mass.gov/dep/ors/orspubs.htm)
VR _{work} - Ventilation Rate during work (heavy exertion)	60	L/min	Table B-4 MADEP 1995 Guidance for Disposal Site Risk Characterization.
SA - Surface Area	3473	cm ² /day	MADEP. 1995. Guidance for Disposal Site Risk Characterization. 50th percentile for females. Appendix Table B-2.
IFAF _{inh-gi} - Ingestion Fraction Adjustment Factor, gastrointestinal	1.5	dimensionless	MADEP 2007. Characterization of Risks Due to Inhalation of Particulates by Construction Workers
IFAF _{inh} - Inhalation Fraction Adjustment Factor, inhalation	0.5	dimensionless	MADEP 2002. Characterization of Risks Due to Inhalation of Particulates by Construction Workers
PM10 - Concentration of PM ₁₀	60	µg/m ³	MADEP 1995 Guidance for Disposal Site Risk Characterization pg B-11

Construction Worker - Soil: Table CW-5
Chemical-Specific Data

Vlookup Version v0315

Oil or Hazardous Material	Oral CSF (mg/kg-day) ⁻¹	RAF _{c-ing}	RAF _{c-derm}	RAF _{c-inh}	Inhalation CSF (mg/kg-day) ⁻¹	Subchronic Oral RfD mg/kg-day	Subchronic RAF _{nc-ing}	Subchronic RAF _{nc-derm}	Subchronic RAF _{nc-inh}	Subchronic Inhalation RfD
POLYCHLORINATED BIPHENYLS (PCBs)	2.0E+00	1	0.1	1	3.5E-01	5.0E-05	1	0.1	1	5.7E-06
ALIPHATICS C9 to C18						1.0E+00	1	0.2	1	1.7E-01
ALIPHATICS C19 to C36						6.0E+00	1	0.2		
AROMATICS C11 to C22						3.0E-01	0.3	0.1	1	1.4E-01
ACENAPHTHENE						2.0E-01	0.3	0.1	1	1.4E-01
ACENAPHTHYLENE						3.0E-01	0.3	0.1	1	1.4E-01
ANTHRACENE						1.0E+00	0.3	0.1	1	1.4E-01
BENZO(a)ANTHRACENE	7.3E-01	0.3	0.02	1	7.3E-01	3.0E-01	0.3	0.02	1	1.4E-01
BENZO(a)PYRENE	7.3E+00	0.3	0.02	1	7.3E+00	3.0E-01	0.3	0.02	1	1.4E-01
BENZO(b)FLUORANTHENE	7.3E-01	0.3	0.02	1	7.3E-01	3.0E-01	0.3	0.02	1	1.4E-01
BENZO(g,h,i)PERYLENE						3.0E-01	0.3	0.1	1	1.4E-01
BENZO(k)FLUORANTHENE	7.3E-02	0.3	0.02	1	7.3E-02	3.0E-01	0.3	0.02	1	1.4E-01
CHRYSENE	7.3E-02	0.3	0.02	1	7.3E-02	3.0E-01	0.3	0.02	1	1.4E-01
DIBENZO(a,h)ANTHRACENE	7.3E+00	0.3	0.02	1	7.3E+00	3.0E-01	0.3	0.02	1	1.4E-01
FLUORANTHENE						1.0E-01	0.3	0.1	1	1.4E-01
FLUORENE						4.0E-01	0.3	0.1	1	1.4E-01
INDENO(1,2,3-cd)PYRENE	7.3E-01	0.3	0.02	1	7.3E-01	3.0E-01	0.3	0.02	1	1.4E-01
METHYLNAPHTHALENE, 2-						4.0E-03	0.3	0.1	1	1.4E-01
NAPHTHALENE						2.0E-01	0.3	0.1	1	8.6E-04
PHENANTHRENE						3.0E-01	0.3	0.1	1	1.4E-01
PYRENE						3.0E-01	0.3	0.1	1	1.4E-01
BARIUM						7.0E-02	1	0.1	1	1.4E-03
BERYLLIUM					8.4E+00	5.0E-03	1	0.1	1	5.7E-06
CHROMIUM(III)						1.5E+00	1	0.1	1	8.6E-05
LEAD						7.5E-04	0.5	0.006	1	2.9E-04
NICKEL					1.7E+00	2.0E-02	1	0.2	1	2.9E-04
VANADIUM						9.0E-03	1	0.1	1	2.9E-04
ZINC						3.0E-01	1	0.1	1	4.0E-04

Method 3 Risk Assessment for Chemicals in Soil - Construction Worker Shortform 2012 (sf12cw)

Index

Tab

EPCs	Table CW-1: Select chemicals and enter Exposure Point Concentrations (EPCs). Estimated risks are shown to the right.
C Eq	Table CW-2: Equations to calculate cancer risks
NC Eq	Table CW-3: Equations to calculate noncancer risks
Exp	Table CW-4: Definitions and exposure factors
Chem	Table CW-5: Chemical-specific data
Cyanide	Table CW-6: Cyanide Calculations

Spreadsheets designed by Andrew Friedmann, MassDEP

Questions and Comments may be addressed to:

Lydia Thompson

Massachusetts Department of Environmental Protection

Office of Research and Standards

One Winter Street

Boston, MA 02108 USA

Telephone: (617) 556-1165

Fax: (617) 556-1006

Email: Lydia.Thompson@state.ma.us

Construction Worker - Soil: Table CW-1
Exposure Point Concentration (EPC) and Risk
Based on Construction Worker 18-25 years of age

Courtyard: 3-11 Foot Interval (PCBs and
Remainder)

ShortForm Version 10-12
Vlookup Version v0315

****Do not insert or delete any rows****

Click on empty cell below and select OHM using arrow.

ELCR (all chemicals) = 1.8E-07
HI (all chemicals) = 3.1E-01

Oil or Hazardous	EPC	ELCR	ELCR	ELCR	ELCR		Subchronic				
Material (OHM)	(mg/kg)	ingestion	dermal	inhalation GI	inhalation pulmonary	ELCR _{total}	HQ _{ing}	HQ _{derm}	HQ _{inh-GI}	HQ _{inh}	HQ _{total}
POLYCHLORINATED BIPHENYLS (PCBs)	2.0E+00	3.5E-08	3.5E-08	9.1E-10	5.3E-11	7.1E-08	4.9E-02	5.0E-02	1.3E-03	3.7E-03	1.0E-01
ALIPHATICS C9 to C18	3.1E+01						3.8E-05	7.7E-05	9.9E-07	1.9E-06	1.2E-04
ALIPHATICS C19 to C36	9.3E+01						1.9E-05	3.8E-05	4.9E-07		5.8E-05
AROMATICS C11 to C22	1.8E+02						2.2E-04	7.4E-04	5.7E-06	1.3E-05	9.8E-04
ACENAPHTHENE	3.3E-01						6.1E-07	2.0E-06	1.6E-08	2.5E-08	2.7E-06
ACENAPHTHYLENE	9.6E-02						1.2E-07	4.0E-07	3.1E-09	7.2E-09	5.3E-07
ANTHRACENE	7.5E-01						2.8E-07	9.3E-07	7.2E-09	5.6E-08	1.3E-06
BENZO(a)ANTHRACENE	1.6E+00	3.1E-09	2.1E-09	8.0E-11	8.9E-11	5.3E-09	2.0E-06	1.3E-06	5.1E-08	1.2E-07	3.5E-06
BENZO(a)PYRENE	1.5E+00	2.9E-08	1.9E-08	7.5E-10	8.3E-10	5.0E-08	1.8E-06	1.2E-06	4.8E-08	1.1E-07	3.2E-06
BENZO(b)FLUORANTHENE	2.0E+00	3.8E-09	2.6E-09	1.0E-10	1.1E-10	6.6E-09	2.5E-06	1.7E-06	6.4E-08	1.5E-07	4.3E-06
BENZO(g,h,i)PERYLENE	8.5E-01						1.0E-06	3.5E-06	2.7E-08	6.3E-08	4.7E-06
BENZO(k)FLUORANTHENE	7.7E-01	1.5E-10	9.9E-11	3.8E-12	4.3E-12	2.6E-10	9.5E-07	6.4E-07	2.5E-08	5.7E-08	1.7E-06
CHRYSENE	1.8E+00	3.5E-10	2.3E-10	9.0E-12	1.0E-11	6.0E-10	2.2E-06	1.5E-06	5.7E-08	1.3E-07	3.9E-06
DIBENZO(a,h)ANTHRACENE	2.4E-01	4.6E-09	3.1E-09	1.2E-10	1.3E-10	8.0E-09	3.0E-07	2.0E-07	7.7E-09	1.8E-08	5.2E-07
FLUORANTHENE	3.7E+00						1.4E-05	4.6E-05	3.5E-07	2.8E-07	6.0E-05
FLUORENE	3.7E-01						3.4E-07	1.1E-06	8.9E-09	2.8E-08	1.5E-06
INDENO(1,2,3-cd)PYRENE	8.9E-01	1.7E-09	1.1E-09	4.4E-11	4.9E-11	3.0E-09	1.1E-06	7.4E-07	2.8E-08	6.6E-08	1.9E-06
METHYLNAPHTHALENE, 2-	1.7E-01						1.6E-05	5.3E-05	4.1E-07	1.3E-08	6.9E-05
NAPHTHALENE	2.0E-01						3.7E-07	1.2E-06	9.6E-09	2.5E-06	4.1E-06
PHENANTHRENE	3.1E+00						3.8E-06	1.3E-05	9.9E-08	2.3E-07	1.7E-05
PYRENE	3.4E+00						4.2E-06	1.4E-05	1.1E-07	2.5E-07	1.9E-05
BARIUM	4.9E+01						8.6E-04	8.7E-04	2.2E-05	3.6E-04	2.1E-03
BERYLLIUM	1.9E+00				1.2E-09	1.2E-09	4.7E-04	4.7E-04	1.2E-05	3.5E-03	4.5E-03
CHROMIUM(III)	1.7E+01						1.4E-05	1.4E-05	3.6E-07	2.1E-03	2.1E-03
LEAD	1.0E+02						8.5E-02	1.0E-02	2.2E-03	3.9E-03	1.0E-01
NICKEL	2.4E+01				3.1E-09	3.1E-09	1.5E-03	3.0E-03	3.8E-05	8.9E-04	5.4E-03
VANADIUM	1.8E+02						2.4E-02	2.5E-02	6.3E-04	6.6E-03	5.6E-02
ZINC	9.4E+01						3.9E-04	3.9E-04	1.0E-05	2.5E-03	3.3E-03
CHLORDANE	1.3E-01	4.0E-10	1.6E-10	1.0E-11	3.4E-12	5.7E-10	3.2E-04	1.3E-04	8.3E-06	6.9E-07	4.6E-04
DICHLORODIPHENYLTRICHLOROETHANE, P,P'- (DDT)	3.7E-02	1.1E-10	3.3E-11	2.9E-12	9.5E-13	1.5E-10	9.1E-05	2.8E-05	2.4E-06	7.7E-07	1.2E-04
DIELDRIN	3.2E-02	4.5E-09	4.5E-09	1.2E-10	3.9E-11	9.2E-09	7.9E-04	7.9E-04	2.0E-05	6.6E-06	1.6E-03
BENZENE	5.3E-02	2.6E-11	7.7E-12	6.6E-13	1.1E-13	3.4E-11	6.5E-06	2.0E-06	1.7E-07	2.0E-07	8.9E-06

Construction Worker - Soil: Table CW-2

Equations to Calculate Cancer Risk for Construction Worker

Vlookup Version v0315

Cancer Risk from Ingestion

$$ELCR_{ing} = LADD_{ing} * CSF_{oral}$$

$$LADD_{ing} = \frac{EPC * IR * RAF_{c-ing} * EF * ED_{ing} * EP * C1}{BW * AP_{lifetime}}$$

Cancer Risk from Dermal Absorption

$$ELCR_{derm} = LADD_{derm} * CSF_{oral}$$

$$LADD_{derm} = \frac{EPC * SA * AF * RAF_{c-derm} * EF * ED_{derm} * EP * C1}{BW * AP_{lifetime}}$$

Cancer Risk from Particulate Inhalation - Gastrointestinal Absorption

$$ELCR_{inh-GI} = LADD_{inh-GI} * CSF_{oral}$$

$$LADD_{inh-GI} = \frac{EPC * RCAF_{inh-gi} * PM_{10} * VR_{work} * RAF_{c-ing} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{lifetime}}$$

Cancer Risk from Particulate Inhalation - Pulmonary Absorption

$$ELCR_{inh} = LADD_{inh} * CSF_{inhalation}$$

$$LADD = \frac{EPC * RCAF_{inh} * PM_{10} * VR_{work} * RAF_{c-inh} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{lifetime}}$$

Parameter	Value	Units
CSF	OHM-specific	(mg/kg-day) ⁻¹
LADD	age/OHM-specific	mg/kg-day
EPC	OHM-specific	mg/kg
IR	100	mg/day
RAF _{c-ing}	OHM-specific	dimensionless
RAF _{c-derm}	OHM-specific	dimensionless
RAF _{c-inh}	OHM-specific	dimensionless
EF	0.714	event/day
ED _{ing & derm}	1	day/event
ED _{inh}	0.333	day/event
EP	182	days
C1	1.0E-06	kg/mg
C2	1.0E-09	kg/μg
C3	1440	min/days
C4	1.0E-03	m ³ /L
BW	58.0	kg
AP _(lifetime)	25,550	days
VR _{work}	60	L/min
AF	0.29	mg/cm ²
SA	3473	cm ² /day
RCAF _{inh-gi}	1.5	dimensionless
RCAF _{inh}	0.5	dimensionless
PM ₁₀	60	μg/m ³

Construction Worker - Soil: Table CW-3 **Equations to Calculate Noncancer Risk for Construction Worker**

Vlookup Version v0315

Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD_{oral-subchronic}}$$

$$ADD_{ing} = \frac{EPC * IR * RAF_{nc-ing} * EF * ED_{ing} * EP * C1}{BW * AP_{noncancer}}$$

Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{derm}}{RfD_{oral-subchronic}}$$

$$ADD_{derm} = \frac{EPC * SA * AF * RAF_{nc-derm} * EF * ED_{dermal} * EP * C1}{BW * AP_{noncancer}}$$

Noncancer Risk from Particulate Inhalation - Gastrointestinal Absorption

$$HQ_{inh-GI} = \frac{ADD_{inh-GI}}{RfD_{oral-subchronic}}$$

$$ADD_{inh-GI} = \frac{EPC * RCAF_{inh-gi} * PM_{10} * VR_{work} * RAF_{nc-ing} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{noncancer}}$$

Noncancer Risk from Particulate Inhalation - Pulmonary Absorption

$$HQ_{inh} = \frac{ADD}{RfD_{inhalation-subchronic}}$$

$$ADD_{inh} = \frac{EPC_{soil} * RCAF_{inh} * PM_{10} * VR_{work} * RAF_{nc-inh} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{noncancer}}$$

Parameter	Value	Units
RfD	OHM-specific	mg/kg-day
ADD	OHM-specific	mg/kg-day
EPC	OHM-specific	mg/kg
IR	100	mg/day
RAF _{nc-ing}	OHM-specific	dimensionless
RAF _{nc-derm}	OHM-specific	dimensionless
RAF _{nc-inh}	OHM-specific	dimensionless
EF	0.714	event/day
ED _{ing & derm}	1	day/event
ED _{inh}	0.333	day/event
EP	182	days
C1	1.0E-06	kg/mg
C2	1.0E-09	kg/μg
C3	1440	min/days
C4	1.0E-03	m ³ /L
BW	58.0	kg
AP _{noncancer}	182	days
VR _{work}	60	L/min
AF	0.29	mg/cm ²
SA	3473	cm ² /day
RCAF _{inh-gi}	1.5	dimensionless
RCAF _{inh}	0.5	dimensionless
PM10	60	μg/m ³

Construction Worker - Soil: Table CW-4

Definitions and Exposure Factors

Vlookup Version v0315

Parameter	Value	Units	Notes
ELCR - Excess Lifetime Cancer Risk	chemical specific	dimensionless	Pathway specific (ing =ingestion, derm=dermal, inh=inhilation)
HI - Hazard Index	chemical specific	dimensionless	Pathway specific (ing =ingestion, derm=dermal, inh=inhilation)
CSF - Cancer Slope Factor	chemical specific	(mg/kg-day) ⁻¹	see Table CW-5.
RfD - Reference Dose	chemical specific	mg/kg-day	see Table CW-5.
LADD - Lifetime Average Daily Dose	chemical specific	mg/kg-day	Pathway specific. See Table CW-2.
ADD - Average Daily Dose	chemical specific	mg/kg-day	Pathway specific. See Table CW-3.
EPC - Exposure Point Concentration	chemical specific	mg/kg	see Table CW-1.
IR - Soil Ingestion Rate	100	mg/day	MADEP. 2002. Technical Update: Calculation of an Enhanced Soil Ingestion Rate. (http://www.mass.gov/dep/ors/orspubs.htm).
RAF _c - Relative Absorption Factor for Cancer Effects	chemical specific	dimensionless	Pathway specific - see Table CW-5.
RAF _{nc} - Relative Absorption Factor for Noncancer Effects	chemical specific	dimensionless	Pathway specific - see Table CW-5.
EF - Exposure Frequency	0.714	event/day	5 events (days) / 7 events (days) in a week; MADEP 1995 Guidance for Disposal Site Risk Characterization pg B-38.
ED _{ing,derm} - Exposure Duration for ingestion or dermal exposure	1	day/event	
ED _{inh} - Exposure Duration for inhalation exposure	0.333	day/event	Represents 8 hours / event.
EP - Exposure Period	182	days	6 months; MADEP 1995 Guidance for Disposal Site Risk Characterization.
BW - Body Weight	58.0	kg	U.S. EPA. 1997. Exposure Factors Handbook. Table 7-7, Females, ages 18 - 25.
AP _(lifetime) - Averaging Period for lifetime	25,550	days	Represents 70 years
AP _(noncancer) - Averaging Period for noncancer	182	days	6 months; MADEP 1995 Guidance for Disposal Site Risk Characterization.
AF - Adherence Factor	0.29	mg/cm ²	MA DEP. 2002 Technical Update: Weighted Skin-Soil Adherence Factors. (http://www.mass.gov/dep/ors/orspubs.htm)
VR _{work} - Ventilation Rate during work (heavy exertion)	60	L/min	Table B-4 MADEP 1995 Guidance for Disposal Site Risk Characterization.
SA - Surface Area	3473	cm ² /day	MADEP. 1995. Guidance for Disposal Site Risk Characterization. 50th percentile for females. Appendix Table B-2.
IFAF _{inh-gi} - Ingestion Fraction Adjustment Factor, gastrointestinal	1.5	dimensionless	MADEP 2007. Characterization of Risks Due to Inhalation of Particulates by Construction Workers
IFAF _{inh} - Inhalation Fraction Adjustment Factor, inhalation	0.5	dimensionless	MADEP 2002. Characterization of Risks Due to Inhalation of Particulates by Construction Workers
PM10 - Concentration of PM ₁₀	60	µg/m ³	MADEP 1995 Guidance for Disposal Site Risk Characterization pg B-11

Construction Worker - Soil: Table CW-5
Chemical-Specific Data

Vlookup Version v0315

Oil or Hazardous Material	Oral CSF (mg/kg-day) ⁻¹	RAF _{c-ing}	RAF _{c-derm}	RAF _{c-inh}	Inhalation CSF (mg/kg-day) ⁻¹	Subchronic Oral RfD mg/kg-day	Subchronic RAF _{nc-ing}	Subchronic RAF _{nc-derm}	Subchronic RAF _{nc-inh}	Subchronic Inhalation RfD
POLYCHLORINATED BIPHENYLS (PCBs)	2.0E+00	1	0.1	1	3.5E-01	5.0E-05	1	0.1	1	5.7E-06
ALIPHATICS C9 to C18						1.0E+00	1	0.2	1	1.7E-01
ALIPHATICS C19 to C36						6.0E+00	1	0.2		
AROMATICS C11 to C22						3.0E-01	0.3	0.1	1	1.4E-01
ACENAPHTHENE						2.0E-01	0.3	0.1	1	1.4E-01
ACENAPHTHYLENE						3.0E-01	0.3	0.1	1	1.4E-01
ANTHRACENE						1.0E+00	0.3	0.1	1	1.4E-01
BENZO(a)ANTHRACENE	7.3E-01	0.3	0.02	1	7.3E-01	3.0E-01	0.3	0.02	1	1.4E-01
BENZO(a)PYRENE	7.3E+00	0.3	0.02	1	7.3E+00	3.0E-01	0.3	0.02	1	1.4E-01
BENZO(b)FLUORANTHENE	7.3E-01	0.3	0.02	1	7.3E-01	3.0E-01	0.3	0.02	1	1.4E-01
BENZO(g,h,i)PERYLENE						3.0E-01	0.3	0.1	1	1.4E-01
BENZO(k)FLUORANTHENE	7.3E-02	0.3	0.02	1	7.3E-02	3.0E-01	0.3	0.02	1	1.4E-01
CHRYSENE	7.3E-02	0.3	0.02	1	7.3E-02	3.0E-01	0.3	0.02	1	1.4E-01
DIBENZO(a,h)ANTHRACENE	7.3E+00	0.3	0.02	1	7.3E+00	3.0E-01	0.3	0.02	1	1.4E-01
FLUORANTHENE						1.0E-01	0.3	0.1	1	1.4E-01
FLUORENE						4.0E-01	0.3	0.1	1	1.4E-01
INDENO(1,2,3-cd)PYRENE	7.3E-01	0.3	0.02	1	7.3E-01	3.0E-01	0.3	0.02	1	1.4E-01
METHYLNAPHTHALENE, 2-						4.0E-03	0.3	0.1	1	1.4E-01
NAPHTHALENE						2.0E-01	0.3	0.1	1	8.6E-04
PHENANTHRENE						3.0E-01	0.3	0.1	1	1.4E-01
PYRENE						3.0E-01	0.3	0.1	1	1.4E-01
BARIUM						7.0E-02	1	0.1	1	1.4E-03
BERYLLIUM					8.4E+00	5.0E-03	1	0.1	1	5.7E-06
CHROMIUM(III)						1.5E+00	1	0.1	1	8.6E-05
LEAD						7.5E-04	0.5	0.006	1	2.9E-04
NICKEL					1.7E+00	2.0E-02	1	0.2	1	2.9E-04
VANADIUM						9.0E-03	1	0.1	1	2.9E-04
ZINC						3.0E-01	1	0.1	1	4.0E-04

Method 3 Risk Assessment for Chemicals in Soil - Construction Worker Shortform 2012 (sf12cw)

Index

Tab

EPCs	Table CW-1: Select chemicals and enter Exposure Point Concentrations (EPCs). Estimated risks are shown to the right.
C Eq	Table CW-2: Equations to calculate cancer risks
NC Eq	Table CW-3: Equations to calculate noncancer risks
Exp	Table CW-4: Definitions and exposure factors
Chem	Table CW-5: Chemical-specific data
Cyanide	Table CW-6: Cyanide Calculations

Spreadsheets designed by Andrew Friedmann, MassDEP

Questions and Comments may be addressed to:

Lydia Thompson

Massachusetts Department of Environmental Protection

Office of Research and Standards

One Winter Street

Boston, MA 02108 USA

Telephone: (617) 556-1165

Fax: (617) 556-1006

Email: Lydia.Thompson@state.ma.us

Construction Worker - Soil: Table CW-1
Exposure Point Concentration (EPC) and Risk
Based on Construction Worker 18-25 years of age

Courtyard: Fuel Oil Vault Sands /
Stockpile SP-3

ShortForm Version 10-12
Vlookup Version v0315

****Do not insert or delete any rows****

Click on empty cell below and select OHM using arrow.

ELCR (all chemicals) = 7.7E-07
HI (all chemicals) = **1.3E+00**

Oil or Hazardous	EPC	ELCR	ELCR	ELCR	ELCR		Subchronic				
Material (OHM)	(mg/kg)	ingestion	dermal	inhalation GI	inhalation pulmonary	ELCR _{total}	HQ _{ing}	HQ _{derm}	HQ _{inh-GI}	HQ _{inh}	HQ _{total}
POLYCHLORINATED BIPHENYLS (PCBs)	1.3E+01	2.3E-07	2.3E-07	5.9E-09	3.4E-10	4.6E-07	3.2E-01	3.2E-01	8.3E-03	2.4E-02	6.8E-01
ALIPHATICS C9 to C18											
ALIPHATICS C19 to C36											
AROMATICS C11 to C22											
ACENAPHTHENE	7.0E-01						1.3E-06	4.3E-06	3.4E-08	5.2E-08	5.7E-06
ACENAPHTHYLENE	9.0E-02						1.1E-07	3.7E-07	2.9E-09	6.7E-09	4.9E-07
ANTHRACENE	1.5E+00						5.5E-07	1.9E-06	1.4E-08	1.1E-07	2.5E-06
BENZO(a)ANTHRACENE	3.0E+00	5.8E-09	3.9E-09	1.5E-10	1.7E-10	9.9E-09	3.7E-06	2.5E-06	9.6E-08	2.2E-07	6.5E-06
BENZO(a)PYRENE	2.6E+00	5.0E-08	3.4E-08	1.3E-09	1.4E-09	8.6E-08	3.2E-06	2.2E-06	8.3E-08	1.9E-07	5.6E-06
BENZO(b)FLUORANTHENE	3.5E+00	6.7E-09	4.5E-09	1.7E-10	1.9E-10	1.2E-08	4.3E-06	2.9E-06	1.1E-07	2.6E-07	7.6E-06
BENZO(g,h,i)PERYLENE	1.4E+00						1.7E-06	5.8E-06	4.5E-08	1.0E-07	7.7E-06
BENZO(k)FLUORANTHENE	1.4E+00	2.7E-10	1.8E-10	7.0E-12	7.7E-12	4.6E-10	1.7E-06	1.2E-06	4.5E-08	1.0E-07	3.0E-06
CHRYSENE	2.8E+00	5.4E-10	3.6E-10	1.4E-11	1.5E-11	9.3E-10	3.4E-06	2.3E-06	8.9E-08	2.1E-07	6.1E-06
DIBENZO(a,h)ANTHRACENE	5.9E-01	1.1E-08	7.6E-09	2.9E-10	3.3E-10	2.0E-08	7.3E-07	4.9E-07	1.9E-08	4.4E-08	1.3E-06
FLUORANTHENE	7.0E+00						2.6E-05	8.7E-05	6.7E-07	5.2E-07	1.1E-04
FLUORENE	9.3E-01						8.6E-07	2.9E-06	2.2E-08	6.9E-08	3.8E-06
INDENO(1,2,3-cd)PYRENE	1.4E+00	2.7E-09	1.8E-09	7.0E-11	7.7E-11	4.6E-09	1.7E-06	1.2E-06	4.5E-08	1.0E-07	3.0E-06
METHYLNAPHTHALENE, 2-	2.9E-01						2.7E-05	9.0E-05	6.9E-07	2.2E-08	1.2E-04
NAPHTHALENE	5.9E-01						1.1E-06	3.7E-06	2.8E-08	7.3E-06	1.2E-05
PHENANTHRENE	5.9E+00						7.3E-06	2.4E-05	1.9E-07	4.4E-07	3.2E-05
PYRENE	5.0E+00						6.2E-06	2.1E-05	1.6E-07	3.7E-07	2.7E-05
BARIUM	1.0E+02						1.8E-03	1.8E-03	4.7E-05	7.7E-04	4.5E-03
BERYLLIUM	9.3E-01				5.9E-10	5.9E-10	2.3E-04	2.3E-04	5.9E-06	1.7E-03	2.2E-03
CHROMIUM(III)	3.4E+01						2.8E-05	2.8E-05	7.2E-07	4.2E-03	4.3E-03
LEAD	4.2E+02						3.5E-01	4.2E-02	9.0E-03	1.6E-02	4.1E-01
NICKEL	2.5E+01				3.2E-09	3.2E-09	1.5E-03	3.1E-03	4.0E-05	9.3E-04	5.6E-03
THALLIUM	3.5E+00						5.4E-03	5.4E-04	1.4E-04	9.3E-03	1.5E-02
VANADIUM	1.1E+02						1.5E-02	1.5E-02	3.8E-04	4.0E-03	3.4E-02
ZINC	1.6E+02						6.6E-04	6.7E-04	1.7E-05	4.3E-03	5.6E-03
DICHLORODIPHENYLTRICHLOROETHANE, P,P'- (DDT)	1.1E-01	3.3E-10	9.9E-11	8.5E-12	2.8E-12	4.4E-10	2.7E-04	8.2E-05	7.0E-06	2.3E-06	3.6E-04
DIELDRIN	1.7E-01	2.4E-08	2.4E-08	6.2E-10	2.1E-10	4.9E-08	4.2E-03	4.2E-03	1.1E-04	3.5E-05	8.5E-03
TCDD, 2,3,7,8- (equivalents)	4.3E-05	5.6E-08	5.7E-08	1.5E-09	3.8E-10	1.2E-07	7.5E-02	7.6E-02	2.0E-03	8.0E-04	1.5E-01

Construction Worker - Soil: Table CW-2

Equations to Calculate Cancer Risk for Construction Worker

Vlookup Version v0315

Cancer Risk from Ingestion

$$ELCR_{ing} = LADD_{ing} * CSF_{oral}$$

$$LADD_{ing} = \frac{EPC * IR * RAF_{c-ing} * EF * ED_{ing} * EP * C1}{BW * AP_{lifetime}}$$

Cancer Risk from Dermal Absorption

$$ELCR_{derm} = LADD_{derm} * CSF_{oral}$$

$$LADD_{derm} = \frac{EPC * SA * AF * RAF_{c-derm} * EF * ED_{derm} * EP * C1}{BW * AP_{lifetime}}$$

Cancer Risk from Particulate Inhalation - Gastrointestinal Absorption

$$ELCR_{inh-GI} = LADD_{inh-GI} * CSF_{oral}$$

$$LADD_{inh-GI} = \frac{EPC * RCAF_{inh-gi} * PM_{10} * VR_{work} * RAF_{c-ing} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{lifetime}}$$

Cancer Risk from Particulate Inhalation - Pulmonary Absorption

$$ELCR_{inh} = LADD_{inh} * CSF_{inhalation}$$

$$LADD = \frac{EPC * RCAF_{inh} * PM_{10} * VR_{work} * RAF_{c-inh} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{lifetime}}$$

Parameter	Value	Units
CSF	OHM-specific	(mg/kg-day) ⁻¹
LADD	age/OHM-specific	mg/kg-day
EPC	OHM-specific	mg/kg
IR	100	mg/day
RAF _{c-ing}	OHM-specific	dimensionless
RAF _{c-derm}	OHM-specific	dimensionless
RAF _{c-inh}	OHM-specific	dimensionless
EF	0.714	event/day
ED _{ing & derm}	1	day/event
ED _{inh}	0.333	day/event
EP	182	days
C1	1.0E-06	kg/mg
C2	1.0E-09	kg/μg
C3	1440	min/days
C4	1.0E-03	m ³ /L
BW	58.0	kg
AP _(lifetime)	25,550	days
VR _{work}	60	L/min
AF	0.29	mg/cm ²
SA	3473	cm ² /day
RCAF _{inh-gi}	1.5	dimensionless
RCAF _{inh}	0.5	dimensionless
PM ₁₀	60	μg/m ³

Construction Worker - Soil: Table CW-3
Equations to Calculate Noncancer Risk for Construction Worker

Vlookup Version v0315

Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD_{oral-subchronic}}$$

$$ADD_{ing} = \frac{EPC * IR * RAF_{nc-ing} * EF * ED_{ing} * EP * C1}{BW * AP_{noncancer}}$$

Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{derm}}{RfD_{oral-subchronic}}$$

$$ADD_{derm} = \frac{EPC * SA * AF * RAF_{nc-derm} * EF * ED_{dermal} * EP * C1}{BW * AP_{noncancer}}$$

Noncancer Risk from Particulate Inhalation - Gastrointestinal Absorption

$$HQ_{inh-GI} = \frac{ADD_{inh-GI}}{RfD_{oral-subchronic}}$$

$$ADD_{inh-GI} = \frac{EPC * RCAF_{inh-gi} * PM_{10} * VR_{work} * RAF_{nc-ing} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{noncancer}}$$

Noncancer Risk from Particulate Inhalation - Pulmonary Absorption

$$HQ_{inh} = \frac{ADD}{RfD_{inhalation-subchronic}}$$

$$ADD_{inh} = \frac{EPC_{soil} * RCAF_{inh} * PM_{10} * VR_{work} * RAF_{nc-inh} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{noncancer}}$$

Parameter	Value	Units
RfD	OHM-specific	mg/kg-day
ADD	OHM-specific	mg/kg-day
EPC	OHM-specific	mg/kg
IR	100	mg/day
RAF _{nc-ing}	OHM-specific	dimensionless
RAF _{nc-derm}	OHM-specific	dimensionless
RAF _{nc-inh}	OHM-specific	dimensionless
EF	0.714	event/day
ED _{ing & derm}	1	day/event
ED _{inh}	0.333	day/event
EP	182	days
C1	1.0E-06	kg/mg
C2	1.0E-09	kg/μg
C3	1440	min/days
C4	1.0E-03	m ³ /L
BW	58.0	kg
AP _{noncancer}	182	days
VR _{work}	60	L/min
AF	0.29	mg/cm ²
SA	3473	cm ² /day
RCAF _{inh-gi}	1.5	dimensionless
RCAF _{inh}	0.5	dimensionless
PM10	60	μg/m ³

Construction Worker - Soil: Table CW-4

Definitions and Exposure Factors

Vlookup Version v0315

Parameter	Value	Units	Notes
ELCR - Excess Lifetime Cancer Risk	chemical specific	dimensionless	Pathway specific (ing =ingestion, derm=dermal, inh=inhilation)
HI - Hazard Index	chemical specific	dimensionless	Pathway specific (ing =ingestion, derm=dermal, inh=inhilation)
CSF - Cancer Slope Factor	chemical specific	(mg/kg-day) ⁻¹	see Table CW-5.
RfD - Reference Dose	chemical specific	mg/kg-day	see Table CW-5.
LADD - Lifetime Average Daily Dose	chemical specific	mg/kg-day	Pathway specific. See Table CW-2.
ADD - Average Daily Dose	chemical specific	mg/kg-day	Pathway specific. See Table CW-3.
EPC - Exposure Point Concentration	chemical specific	mg/kg	see Table CW-1.
IR - Soil Ingestion Rate	100	mg/day	MADEP. 2002. Technical Update: Calculation of an Enhanced Soil Ingestion Rate. (http://www.mass.gov/dep/ors/orspubs.htm).
RAF _c - Relative Absorption Factor for Cancer Effects	chemical specific	dimensionless	Pathway specific - see Table CW-5.
RAF _{nc} - Relative Absorption Factor for Noncancer Effects	chemical specific	dimensionless	Pathway specific - see Table CW-5.
EF - Exposure Frequency	0.714	event/day	5 events (days) / 7 events (days) in a week; MADEP 1995 Guidance for Disposal Site Risk Characterization pg B-38.
ED _{ing,derm} - Exposure Duration for ingestion or dermal exposure	1	day/event	
ED _{inh} - Exposure Duration for inhalation exposure	0.333	day/event	Represents 8 hours / event.
EP - Exposure Period	182	days	6 months; MADEP 1995 Guidance for Disposal Site Risk Characterization.
BW - Body Weight	58.0	kg	U.S. EPA. 1997. Exposure Factors Handbook. Table 7-7, Females, ages 18 - 25.
AP _(lifetime) - Averaging Period for lifetime	25,550	days	Represents 70 years
AP _(noncancer) - Averaging Period for noncancer	182	days	6 months; MADEP 1995 Guidance for Disposal Site Risk Characterization.
AF - Adherence Factor	0.29	mg/cm ²	MA DEP. 2002 Technical Update: Weighted Skin-Soil Adherence Factors. (http://www.mass.gov/dep/ors/orspubs.htm)
VR _{work} - Ventilation Rate during work (heavy exertion)	60	L/min	Table B-4 MADEP 1995 Guidance for Disposal Site Risk Characterization.
SA - Surface Area	3473	cm ² /day	MADEP. 1995. Guidance for Disposal Site Risk Characterization. 50th percentile for females. Appendix Table B-2.
IFAF _{inh-gi} - Ingestion Fraction Adjustment Factor, gastrointestinal	1.5	dimensionless	MADEP 2007. Characterization of Risks Due to Inhalation of Particulates by Construction Workers
IFAF _{inh} - Inhalation Fraction Adjustment Factor, inhalation	0.5	dimensionless	MADEP 2002. Characterization of Risks Due to Inhalation of Particulates by Construction Workers
PM10 - Concentration of PM ₁₀	60	µg/m ³	MADEP 1995 Guidance for Disposal Site Risk Characterization pg B-11

Construction Worker - Soil: Table CW-5
Chemical-Specific Data

Vlookup Version v0315

Oil or Hazardous Material	Oral CSF (mg/kg-day) ⁻¹	RAF _{c-ing}	RAF _{c-derm}	RAF _{c-inh}	Inhalation CSF (mg/kg-day) ⁻¹	Subchronic Oral RfD mg/kg-day	Subchronic RAF _{nc-ing}	Subchronic RAF _{nc-derm}	Subchronic RAF _{nc-inh}	Subchronic Inhalation RfD
POLYCHLORINATED BIPHENYLS (PCBs)	2.0E+00	1	0.1	1	3.5E-01	5.0E-05	1	0.1	1	5.7E-06
ALIPHATICS C9 to C18						1.0E+00	1	0.2	1	1.7E-01
ALIPHATICS C19 to C36						6.0E+00	1	0.2		
AROMATICS C11 to C22						3.0E-01	0.3	0.1	1	1.4E-01
ACENAPHTHENE						2.0E-01	0.3	0.1	1	1.4E-01
ACENAPHTHYLENE						3.0E-01	0.3	0.1	1	1.4E-01
ANTHRACENE						1.0E+00	0.3	0.1	1	1.4E-01
BENZO(a)ANTHRACENE	7.3E-01	0.3	0.02	1	7.3E-01	3.0E-01	0.3	0.02	1	1.4E-01
BENZO(a)PYRENE	7.3E+00	0.3	0.02	1	7.3E+00	3.0E-01	0.3	0.02	1	1.4E-01
BENZO(b)FLUORANTHENE	7.3E-01	0.3	0.02	1	7.3E-01	3.0E-01	0.3	0.02	1	1.4E-01
BENZO(g,h,i)PERYLENE						3.0E-01	0.3	0.1	1	1.4E-01
BENZO(k)FLUORANTHENE	7.3E-02	0.3	0.02	1	7.3E-02	3.0E-01	0.3	0.02	1	1.4E-01
CHRYSENE	7.3E-02	0.3	0.02	1	7.3E-02	3.0E-01	0.3	0.02	1	1.4E-01
DIBENZO(a,h)ANTHRACENE	7.3E+00	0.3	0.02	1	7.3E+00	3.0E-01	0.3	0.02	1	1.4E-01
FLUORANTHENE						1.0E-01	0.3	0.1	1	1.4E-01
FLUORENE						4.0E-01	0.3	0.1	1	1.4E-01
INDENO(1,2,3-cd)PYRENE	7.3E-01	0.3	0.02	1	7.3E-01	3.0E-01	0.3	0.02	1	1.4E-01
METHYLNAPHTHALENE, 2-						4.0E-03	0.3	0.1	1	1.4E-01
NAPHTHALENE						2.0E-01	0.3	0.1	1	8.6E-04
PHENANTHRENE						3.0E-01	0.3	0.1	1	1.4E-01
PYRENE						3.0E-01	0.3	0.1	1	1.4E-01
BARIUM						7.0E-02	1	0.1	1	1.4E-03
BERYLLIUM					8.4E+00	5.0E-03	1	0.1	1	5.7E-06
CHROMIUM(III)						1.5E+00	1	0.1	1	8.6E-05
LEAD						7.5E-04	0.5	0.006	1	2.9E-04
NICKEL					1.7E+00	2.0E-02	1	0.2	1	2.9E-04
THALLIUM						8.0E-04	1	0.01	1	4.0E-06
VANADIUM						9.0E-03	1	0.1	1	2.9E-04

Table 2.4
Cancer Dose Response Values:
Oral Slope Factors

Chemical Name	CAS Number	Oral Slope Factor 1/(mg/kg/day)	Weight of Evidence Class	Source	Date Last Revised
acenaphthene	83-32-9			MADEP, 6/14	
acenaphthylene	208-96-8		D	MADEP, 6/14	
anthracene	120-12-7		D	MADEP, 6/14	
barium	7440-39-3			MADEP, 6/14	
benzene	71-43-2	5.5E-02	A	MADEP, 6/14	
benzo(a)anthracene	56-55-3	7.3E-01	B2	MADEP, 6/14	
benzo(a)pyrene	50-32-8	7.3E+00	B2	MADEP, 6/14	
benzo(b)fluoranthene	205-99-2	7.3E-01	B2	MADEP, 6/14	
benzo(k)fluoranthene	207-08-9	7.3E-02	B2	MADEP, 6/14	
benzo(ghi)perylene	191-24-2			MADEP, 6/14	
beryllium	7440-41-7		B1	MADEP, 6/14	
cadmium	7440-43-9		B1	MADEP, 6/14	
chlordane	57-74-9	3.5E-01	B2	MADEP, 6/14	
chromium (III)	16065-83-1			MADEP, 6/14	
chrysene	218-01-9	7.3E-02	B2	MADEP, 6/14	
dibenzo(a,h)anthracene	53-70-3	7.3E+00	B2	MADEP, 6/14	
DDE	72-55-9	3.4E-01	B2	MADEP, 6/14	
DDT	50-29-3	3.4E-01	B2	MADEP, 6/14	
dieldrin	60-57-1	1.6E+01	B2	MADEP, 6/14	
dioxin (TCDD equivalents)	1746-01-6	1.5E+05	B2	MADEP, 6/14	
fluoranthene	206-44-0		D	MADEP, 6/14	
fluorene	86-73-7			MADEP, 6/14	
indeno(123-cd)pyrene	193-39-5	7.3E-01	B2	MADEP, 6/14	
lead	7439-92-1		B2	MADEP, 6/14	
2-methylnaphthalene	91-57-6			MADEP, 6/14	
naphthalene	91-20-3			MADEP, 6/14	
nickel	7440-02-0		A	MADEP, 6/14	
phenanthrene	85-01-8		D	MADEP, 6/14	
polychlorinated biphenyls	1336-36-3	2.0E+00	B2	MADEP, 6/14	
pyrene	129-00-0		D	MADEP, 6/14	
thallium	7440-28-0			MADEP, 6/14	
toluene	108-88-3		D	MADEP, 6/14	
vanadium	7440-62-2			MADEP, 6/14	
zinc	7440-66-6		D	MADEP, 6/14	
C9-C18 Aliphatics	N/A			MADEP, 6/14	
C19-C36 Aliphatics	N/A			MADEP, 6/14	
C11-C22 Aromatics	N/A			MADEP, 6/14	

Notes: mg/kg/day = milligrams per kilogram body weight per day
N/A = not available

Weight of Evidence: A = Human carcinogen
B1 = Probable human carcinogen
B2 = Probable human carcinogen
C = Possible human carcinogen
D = Not classifiable as to human carcinogenicity
E = Evidence of noncarcinogenicity for humans

References: MADEP, 6/14. MCP Toxicity excel spreadsheet used for the development of the MCP Numerical Standards

Table 2.5
Cancer Dose Response Values:
Inhalation Unit Risks Factors

Chemical Name	CAS Number	Unit Risk Factor 1/(mg/cu. m)	Weight of Evidence Class	Source	Date Last Revised
acenaphthene	83-32-9			MADEP 6/14	
acenaphthylene	208-96-8		D	MADEP 6/14	
anthracene	120-12-7		D	MADEP 6/14	
barium	7440-39-3			MADEP 6/14	
benzene	71-43-2	7.8E-03	A	MADEP 6/14	
benzo(a)anthracene	56-55-3	2.1E-01	B2	MADEP 6/14	
benzo(a)pyrene	50-32-8	2.1E+00	B2	MADEP 6/14	
benzo(b)fluoranthene	205-99-2	2.1E-01	B2	MADEP 6/14	
benzo(k)fluoranthene	207-08-9	2.1E-02	B2	MADEP 6/14	
benzo(ghi)perylene	191-24-2			MADEP 6/14	
beryllium	7440-41-7	2.4E+00	B1	MADEP 6/14	
cadmium	7440-43-9	1.8E+00	B1	MADEP 6/14	
chlordan	57-74-9	1.0E-01	B2	MADEP 6/14	
chromium (III)	16065-83-1			MADEP 6/14	
chrysene	218-01-9	2.1E-02	B2	MADEP 6/14	
dibenzo(a,h)anthracene	53-70-3	2.1E+00	B2	MADEP 6/14	
DDE	72-55-9	9.7E-02	B2	MADEP 6/14	
DDT	50-29-3	9.7E-02	B2	MADEP 6/14	
dieldrin	60-57-1	4.6E+00	B2	MADEP 6/14	
dioxin (TCDD equivalents)	1746-01-6	3.3E+04	B2	MADEP 6/14	
fluoranthene	206-44-0		D	MADEP 6/14	
fluorene	86-73-7			MADEP 6/14	
indeno(1,23-cd)pyrene	193-39-5	2.1E-01	B2	MADEP 6/14	
lead	7439-92-1		B2	MADEP 6/14	
2-methylnaphthalene	91-57-6			MADEP 6/14	
naphthalene	91-20-3			MADEP 6/14	
nickel	7440-02-0	4.8E-01	A	MADEP 6/14	
phenanthrene	85-01-8		D	MADEP 6/14	
polychlorinated biphenyls	1336-36-3	1.0E-01	B2	MADEP 6/14	
pyrene	129-00-0		D	MADEP 6/14	
thallium	7440-28-0			MADEP 6/14	
toluene	108-88-3		D	MADEP 6/14	
vanadium	7440-62-2			MADEP 6/14	
zinc	7440-66-6		D	MADEP 6/14	
C9-C18 Aliphatics	N/A			MADEP 6/14	
C19-C36 Aliphatics	N/A			MADEP 6/14	
C11-C22 Aromatics	N/A			MADEP 6/14	

Notes: mg/cu. m. = milligrams per cubic meter

Weight of Evidence: A = Human carcinogen
 B1 = Probable human carcinogen
 B2 = Probable human carcinogen
 C = Possible human carcinogen
 D = Not classifiable as to human carcinogenicity
 E = Evidence of noncarcinogenicity for humans
 N/A = Not available

References: MADEP, 6/14. MCP Toxicity excel spreadsheet used for the development of the MCP Numerical Standards

Table 2.6
Cancer Dose Response Values: Relative Absorption Factors (RAFs)

Chemical Name	CAS Number	Soil Ingestion RAF	Water Ingestion RAF	Soil Dermal RAF	Water Dermal RAF
		Cancer	Cancer	Cancer	Cancer
acenaphthene	83-32-9	NC	NC	NC	NC
acenaphthylene	208-96-8	NC	NC	NC	NC
anthracene	120-12-7	NC	NC	NC	NC
barium	7440-39-3	NC	NC	NC	NC
benzene	71-43-2	1	1	0.03	1
benzo(a)anthracene	56-55-3	0.3	1	0.02	1
benzo(a)pyrene	50-32-8	0.3	1	0.02	1
benzo(b)fluoranthene	205-99-2	0.3	1	0.02	1
benzo(k)fluoranthene	207-08-9	0.3	1	0.02	1
benzo(ghi)perylene	191-24-2	NC	NC	NC	NC
beryllium	7440-41-7	1	1	0.03	1
cadmium	7440-43-9	NC	NC	NC	NC
chromium (III)	16065-83-1	NC	NC	NC	NC
chrysene	218-01-9	0.3	1	0.02	1
dibenz(a,h)anthracene	53-70-3	0.3	1	0.02	1
DDE	72-55-9	1	1	0.03	1
DDT	50-29-2	1	1	0.03	1
dieldrin	60-57-1	1	1	0.1	1
dioxin (TCDD equivalents)	1746-01-6	1	1	0.1	1
ethylbenzene	100-41-4	NC	NC	NC	NC
fluoranthene	206-44-0	NC	NC	NC	NC
fluorene	86-73-7	NC	NC	NC	NC
indeno(123-cd)pyrene	193-39-5	0.3	1	0.02	1
lead	7439-92-1	NC	NC	NC	NC
2-methylnaphthalene	91-57-6	NC	NC	NC	NC
naphthalene	91-20-3	NC	NC	NC	NC
nickel	7440-02-0	NC	NC	NC	NC
phenanthrene	85-01-8	NC	NC	NC	NC
polychlorinated biphenyls	1336-36-3	1	1	0.1	1
pyrene	129-00-0	NC	NC	NC	NC
thallium	7440-28-0	NC	NC	NC	NC
toluene	108-88-3	NC	NC	NC	NC
vanadium	7440-62-2	NC	NC	NC	NC
zinc	7440-66-6	NC	NC	NC	NC
C9-C18 Aliphatics	N/A	NC	NC	NC	NC
C19-C36 Aliphatics	N/A	NC	NC	NC	NC
C11-C22 Aromatics	N/A	NC	NC	NC	NC

Notes:

(1) RAF values from MADEP (1994). Default value of one (1) assigned to dermal contact with water.
NC = RAF not provided because compound is not a Class A, B1, B2 or, when applicable, C carcinogen
N/A = not available or because no oral cancer slope factor is available.

References:

MADEP, 6/14. MCP Toxicity excel spreadsheet used for the development of the MCP Numerical Standards.

Table 3.3
Calculation of Lifetime Average Daily Dose for Soil Exposure: Resident, aged 1 to 2 Years

Receptor: Resident, aged 1-31 years												
Exposure Point:			Courtyard 0-1 Foot Interval		Courtyard 1-3 Foot Interval		Courtyard 3-6 Foot Interval		Courtyard 3-11 Foot Interval		Stockpiled Fuel Oil Vault Sands SP-3	
Chemical Name	CAS Number	Weight of Evidence Class	Dermal Contact	Incidental Ingestion	Dermal Contact	Incidental Ingestion	Dermal Contact	Incidental Ingestion	Dermal Contact	Incidental Ingestion	Dermal Contact	Incidental Ingestion
benzene	71-43-2	A					6.19E-10	1.20E-08	6.19E-10	1.20E-08		
benzo(a)anthracene	56-55-3		3.35E-08	2.92E-07	3.35E-08	2.92E-07	1.40E-08	1.22E-07	1.25E-08	1.09E-07	2.33E-08	2.04E-07
benzo(a)pyrene	50-32-8		3.04E-08	2.65E-07	3.04E-08	2.65E-07	1.25E-08	1.09E-07	1.17E-08	1.02E-07	2.02E-08	1.76E-07
benzo(b)fluoranthene	205-99-2		3.97E-08	3.46E-07	3.97E-08	3.46E-07	1.71E-08	1.49E-07	1.56E-08	1.36E-07	2.72E-08	2.37E-07
benzo(k)fluoranthene	207-08-9		1.40E-08	1.22E-07	1.40E-08	1.22E-07	6.46E-09	5.63E-08	5.99E-09	5.22E-08	1.09E-08	9.50E-08
beryllium	7440-41-7											
chlordane	57-74-9						2.53E-09	2.94E-08	2.53E-09	2.94E-08		
chrysene	218-01-9		3.74E-08	3.26E-07	3.74E-08	3.26E-07	1.48E-08	1.29E-07	1.40E-08	1.22E-07	2.18E-08	1.90E-07
dibenzo(a,h)anthracene	53-70-3		5.06E-09	4.41E-08	5.06E-09	4.41E-08	1.95E-09	1.70E-08	1.87E-09	1.63E-08	4.59E-09	4.00E-08
DDE	72-55-0		6.30E-10	1.22E-08	5.49E-10	1.06E-08						
DDT	50-29-3		1.19E-09	2.31E-08	7.94E-10	1.54E-08	4.32E-10	8.37E-09	4.32E-10	8.37E-09	1.28E-09	2.49E-08
dieldrin	60-57-1		4.20E-09	2.44E-08	1.83E-09	1.06E-08	1.25E-09	7.24E-09	1.25E-09	7.24E-09	6.62E-09	3.84E-08
dioxin (TCDD equivalents)	1746-01-6		5.25E-12	3.05E-11	9.77E-13	5.68E-12	2.44E-13	1.42E-12	2.57E-13	1.49E-12	1.67E-12	9.70E-12
indeno(1,23-cd)pyrene	193-39-5		1.95E-08	1.70E-07	1.95E-08	1.70E-07	7.55E-09	6.58E-08	6.93E-09	6.04E-08	1.09E-08	9.50E-08
nickel	7440-02-0											
polychlorinated biphenyls	1336-36-3		1.60E-06	9.27E-06	2.96E-07	1.72E-06	7.39E-08	4.30E-07	7.78E-08	4.52E-07	5.06E-07	2.94E-06

Formula: Lifetime Average Daily Dose (LADD) for exposure to soils via ingestion (ing) and dermal contact							
<div>LADD-dermal = $\frac{[\text{OHM-soil}] * \text{SA} * \text{AF} * \text{RAF} * \text{EF} * \text{ED} * \text{EP} * \text{C}}{\text{BW} * \text{AP}}$</div> <div>LADD-ing = $\frac{[\text{OHM-soil}] * \text{IR} * \text{RAF} * \text{EF} * \text{ED} * \text{EP} * \text{C}}{\text{BW} * \text{AP}}$</div> <div>Unit: LADD, mg/kg/day</div>							
Receptor: Resident, aged 1 to 31 years							
Description	Abbreviation	Unit	Default Value	Source	Site-Specific Value	Source / Description	Input Value
Exposure point concentration	[OHM-soil]	mg/kg			See Soil EPC Table		See Soil EPC Table
Skin surface area in contact with soil on days exposed	SA	square centimeter/day	4427	[1], child, aged 8 to 15 years (face, hands, forearms, lower legs and feet)			0.00E+00
			5653	[1], adult, aged 15 to 31 years (face, hands, forearms, lower legs and feet)			0.00E+00
			2431	[1], child, aged 1-8 years (face, hands, forearms, lower legs and feet)	1670	child, aged 1 to 2 years (face, hands, forearms, lower legs and feet)	1.67E+03
Mass of soil adhered to the unit surface area of skin exposed	AF	mg/sq. cm.	0.35	[2], child, aged 1-8 years	3.50E-01	child, aged 1 to 2 years	3.50E-01
			0.13	[2], adult, aged 15-31 years			0.00E+00
			0.14	[2], older child, aged 8-15 years			0.00E+00
Relative Absorption Factor	RAF	unitless	See RAF Table				See RAF Table
Exposure frequency: # exposure events during EP / # days in EP	EF	events/year	150	[1] 5 days per week during the 30 warmest weather weeks of the year	182	Exposure presumed to occur seven days per week during a six month construction period	1.82E+02
Exposure duration: typical duration of each exposure event	ED	years/event	2.74E-03	1 day per event or 1/365 of a year per event			2.74E-03
Exposure period: period of time over which exposure may occur	EP	years	7	[1], child, aged 8 to 15 years			7.00E+00
			16	[1], adult, aged 15 to 31 years			1.60E+01
			7	[1], young child, aged 1-8 years	1.0	subchronic exposure of 1 year old boy or girl (Subchronic)	1.00E+00
Unit Conversion Factor	C	kg/mg	1.00E-06	for dermal contact			1.00E-06
Unit Conversion Factor	C	kg/mg	1.00E-06	for ingestion			1.00E-06
Body weight of the receptor during the AP	BW	kg	39.9	[1], child, aged 8-15 years			3.99E+01
			58.7	[1], adult, aged 15 to 31 years			5.87E+01
			17.0	[1], young child, aged 1-8 years	1.07E+01	subchronic exposure of 1 year old boy or girl	1.07E+01
Averaging Period	AP	years	70	[1]			7.00E+01
Ingestion rate	IR	mg/day	50	[1], age 8 or greater			5.00E+01
			100	[1], age 1-8 years			1.00E+02

References:

- [1] MADEP's Guidance for Disposal Site Risk Characterization in Support of the Massachusetts Contingency Plan, Interim Final Policy BWSC/ORS-95-141 [Updated using exposure assumptions of MADEP's Method 1 Numerical Standard Development Workbook, 5/2009].
- [2] MADEP's Technical Update, Weighted Skin-Soil Adherence Factors, April 2002.

Table 3.4
Calculation of Lifetime Average Daily Exposure from Inhalation of Dust: Resident, aged 1 to 2 Years

Receptor: Resident, aged 1 to 31 years									
Chemical Name	CAS Number	Weight of Evidence Class	Courtyard 0-1 Foot Interval	Courtyard 1-3 Foot Interval	Courtyard 3-6 Foot Interval	Courtyard 3-11 Foot Interval	Stockpiled Fuel Oil Vault Sands SP-3		
benzene	71-43-2				2.3E-11	2.3E-11			
benzo(a)anthracene	56-55-3		1.8E-09	1.8E-09	7.7E-10	6.8E-10	1.3E-09		
benzo(a)pyrene	50-32-8		1.7E-09	1.7E-09	6.8E-10	6.4E-10	1.1E-09		
benzo(b)fluoranthene	205-99-2		2.2E-09	2.2E-09	9.4E-10	8.5E-10	1.5E-09		
benzo(k)fluoranthene	207-08-9		7.7E-10	7.7E-10	3.5E-10	3.3E-10	6.0E-10		
beryllium	7440-41-7		2.2E-09	3.9E-09	8.1E-10	8.1E-10	4.0E-10		
chlordane	57-74-9				5.6E-11	5.6E-11			
chrysene	218-01-9		2.1E-09	2.1E-09	8.1E-10	7.7E-10	1.2E-09		
dibenzo(a,h)anthracene	53-70-3		2.8E-10	2.8E-10	1.1E-10	1.0E-10	2.5E-10		
DDE	72-55-9		2.3E-11	2.0E-11					
DDT	50-29-3		4.4E-11	2.9E-11	1.6E-11	1.6E-11	4.7E-11		
dieldrin	60-57-1		4.6E-11	2.0E-11	1.4E-11	1.4E-11	7.3E-11		
dioxin (TCDD equivalents)	1746-01-6		5.8E-14	1.1E-14	2.7E-15	2.8E-15	1.8E-14		
indeno(123-cd)pyrene	193-39-5		1.1E-09	1.1E-09	4.1E-10	3.8E-10	6.0E-10		
nickel	7440-02-0		1.3E-08	1.7E-08	1.0E-08	1.0E-08	1.1E-08		
polychlorinated biphenyls	1336-36-3		1.8E-08	3.2E-09	8.1E-10	8.5E-10	5.6E-09		

A = USEPA Known Human Carcinogen
 B1 or B2 = USEPA Probable Human Carcinogen
 C = USEPA Possible Human Carcinogen
 NC or blank space = Not a carcinogen or insufficient information

Formula: Lifetime Average Daily Exposure (LADE) via inhalation (ihl) of dusts							
LADE-ihl = $\frac{[OHM-dust]*EF*ED*EP*C}{AP}$				Unit: LADE, mg/cu m			
Receptor: Resident, aged 1 to 31 years							
Description	Abbreviation	Unit	Default Value	Source	Site-Specific Value	Source / Description	Input Value
Exposure point concentration	[OHM-dust]	ug/cu. m.			See Dust EPC Table		See Dust EPC Table
Exposure frequency: # exposure events during EP / # days in EP	EF	events/year	150	[1] 5 days per week during the 30 warmest weather weeks of the year			0.00E+00
			150	[1] 5 days per week during the 30 warmest weather weeks of the year	182	Seven days per week during a six-month construction project, during age 1-2 years	1.82E+02
Exposure duration: typical duration of each exposure event	ED	years/event	2.74E-03	1 day per event or 1/365 of a year			2.74E-03
Exposure period: period of time over which exposure may occur	EP	years	23	[1], from age 8 to 31 years			2.30E+01
			7	[1], from age 1 to 8 years	1.00E+00	Presume exposure occurs during a construction project from age 1 to 2 years of age, to either a girl or boy.	1.00E+00
Unit Conversion Factor	C	mg/ug	1.00E-03	for inhalation			1.00E-03
Averaging Period	AP	years	70	[1]			7.00E+01

References:

[1] MADEP's Guidance for Disposal Site Risk Characterization in Support of the Massachusetts Contingency Plan, Interim Final Policy BWSC/ORS-95-141

Table 4.2
Calculation of Excess Lifetime Cancer Risk (ELCR) for Exposure to Soil and Dust: Resident, aged 1 to 2 Years

Receptor: Resident, aged 1 to 31 years																	
Exposure Point:			Courtyard 0-1 Foot Interval			Courtyard 1-3 Foot Interval			Courtyard 3-6 Foot Interval			Courtyard 3-11 Foot Interval			Stockpiled Fuel Oil Vault Sands SP-3		
Chemical Name	CAS Number	Weight of Evidence Class	Dermal Contact	Incidental Ingestion	Dust Inhalation	Dermal Contact	Incidental Ingestion	Dust Inhalation	Dermal Contact	Incidental Ingestion	Dust Inhalation	Dermal Contact	Incidental Ingestion	Dust Inhalation	Dermal Contact	Incidental Ingestion	Dust Inhalation
benzene	71-43-2																
benzo(a)anthracene	56-55-3		2.4E-08	2.1E-07	3.8E-10	2.4E-08	2.1E-07	3.8E-10	3.4E-11	6.6E-10	1.8E-13	3.4E-11	6.6E-10	1.8E-13	3.4E-11	6.6E-10	1.8E-13
benzo(a)pyrene	50-32-8		2.2E-07	1.9E-06	3.5E-09	2.2E-07	1.9E-06	3.5E-09	9.1E-08	7.9E-07	1.4E-09	8.5E-08	7.4E-07	1.3E-09	1.5E-07	1.3E-06	2.3E-09
benzo(b)fluoranthene	205-99-2		2.9E-08	2.5E-07	4.5E-10	2.9E-08	2.5E-07	4.5E-10	1.2E-08	1.1E-07	2.0E-10	1.1E-08	9.9E-08	1.8E-10	2.0E-08	1.7E-07	3.1E-10
benzo(k)fluoranthene	207-08-9		1.0E-09	8.9E-09	1.6E-11	1.0E-09	8.9E-09	1.6E-11	4.7E-10	4.1E-09	7.4E-12	4.4E-10	3.8E-09	6.9E-12	8.0E-10	6.9E-09	1.2E-11
beryllium	7440-41-7				5.2E-09			9.4E-09			1.9E-09			1.9E-09			9.5E-10
chlordane	57-74-9								8.9E-10	1.0E-08	5.6E-12	8.9E-10	1.0E-08	5.6E-12			
chrysene	218-01-9		2.7E-09	2.4E-08	4.3E-11	2.7E-09	2.4E-08	4.3E-11	1.1E-09	9.4E-09	1.7E-11	1.0E-09	8.9E-09	1.6E-11	1.6E-09	1.4E-08	2.5E-11
dibenzo(a,h)anthracene	53-70-3		3.7E-08	3.2E-07	5.8E-10	3.7E-08	3.2E-07	5.8E-10	1.4E-08	1.2E-07	2.2E-10	1.4E-08	1.2E-07	2.2E-10	3.4E-08	2.9E-07	5.3E-10
DDE	72-55-9		2.1E-10	4.2E-09	2.2E-12	1.9E-10	3.6E-09	2.0E-12									
DDT	50-29-3		4.0E-10	7.8E-09	4.2E-12	2.7E-10	5.2E-09	2.8E-12	1.5E-10	2.8E-09	1.5E-12	1.5E-10	2.8E-09	1.5E-12	4.4E-10	8.5E-09	4.6E-12
dieldrin	60-57-1		6.7E-08	3.9E-07	2.1E-10	2.9E-08	1.7E-07	9.2E-11	2.0E-08	1.2E-07	6.3E-11	2.0E-08	1.2E-07	6.3E-11	1.1E-07	6.2E-07	3.3E-10
dioxin (TCDD equivalents)	1746-01-6		7.9E-07	4.6E-06	1.9E-09	1.5E-07	8.5E-07	3.5E-10	3.7E-08	2.1E-07	8.8E-11	3.9E-08	2.2E-07	9.3E-11	2.5E-07	1.5E-06	6.1E-10
indeno(123-cd)pyrene	193-39-5		1.4E-08	1.2E-07	2.2E-10	1.4E-08	1.2E-07	2.2E-10	5.5E-09	4.8E-08	8.6E-11	5.1E-09	4.4E-08	7.9E-11	8.0E-09	6.9E-08	1.2E-10
nickel	7440-02-0				7.0E-09			8.2E-09			4.9E-09			4.9E-09			5.1E-09
polychlorinated biphenyls	1336-36-3		3.2E-06	1.9E-05	1.8E-09	5.9E-07	3.4E-06	3.2E-10	1.5E-07	8.6E-07	8.1E-11	1.6E-07	9.0E-07	8.5E-11	1.0E-06	5.9E-06	5.6E-10
Total ELCR: Route and Expos. Pt.			4.4E-06	2.6E-05	2.1E-08	1.1E-06	7.3E-06	2.4E-08	3.4E-07	2.4E-06	9.2E-09	3.4E-07	2.4E-06	9.1E-09	1.6E-06	1.0E-05	1.1E-08
Proportion of complete exposure point				1.0E+00			1.0E+00			1.0E+00			1.0E+00			1.0E+00	
Adjusted Total ELCR: Route and Expos. Pt.			4.4E-06	2.6E-05	2.1E-08	1.1E-06	7.3E-06	2.4E-08	3.4E-07	2.4E-06	9.2E-09	3.4E-07	2.4E-06	9.1E-09	1.6E-06	1.0E-05	1.1E-08
Total ELCR: Expos. Pt.				3.1E-05			8.5E-06			2.7E-06			2.7E-06			1.2E-05	

Formula:

$$\text{Cumulative ELCR} = \sum ELCR_{\text{ingestion} - \text{chemicalspecific}} + \sum ELCR_{\text{dermalcontact} - \text{chemicalspecific}} + \sum ELCR_{\text{inhalation: chemical} - \text{specific}}$$

ELCR ingestion-chemical specific = LADD-ingestion-chemical specific x Oral Slope Factor-chemical specific
 ELCR dermal contact-chemical specific = LADD-dermal contact-chemical specific x Oral Slope Factor-chemical specific
 ELCR ingestion-chemical specific = LADE-inhalation-chemical specific x Unit Risk-inhalation-chemical specific

ELCR = Excess Lifetime Cancer Risk, unit less
 LADD = Lifetime Average Daily Dose, mg/kg/day
 LADE = Lifetime Average Daily Exposure, mg/cu m

Table 5.2
Calculation of Total Excess Lifetime Cancer Risk (ELCR): Resident, aged 1 to 2 Years

Receptor Exposure Point #	Resident							Youth Trespasser or Visitor						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Pathway:														
Soil Exposure Point:														
Incidental ingestion of soil, normal	2.6E-05	7.3E-06	2.4E-06	2.4E-06	1.0E-05									
Inhalation of dusts from disturbed soil	2.1E-08	2.4E-08	9.2E-09	9.1E-09	1.1E-08									
Dermal contact with soil	4.4E-06	1.1E-06	3.4E-07	3.4E-07	1.6E-06									
Total ELCR	3.1E-05	8.5E-06	2.7E-06	2.7E-06	1.2E-05									
MCP Cancer Risk Limit	1.E-05	1.E-05	1.E-05	1.E-05	1.E-05									
Does Total ELCR exceed MCP Cancer Risk Limit?	Yes	No	No	No	Yes									
Significant Risk of Harm?	No	No	No	No	No									

Definition of exposure points	Resident						
Exposure Point #	1	2	3	4	5	6	7
Soil Exposure Point:	Courtyard 0-1 Foot Interval	Courtyard 1-3 Foot Interval	Courtyard 3-6 Foot Interval	Courtyard 3-11 Foot Interval	Stockpiled Fuel Oil Vault Sands SP-3		

NO SINGLE FAMILY RESIDENCE. NO GARDENING OF EDIBLE PRODUCE.
EXPOSURE TO SOILS OCCURS ONLY DURING A SINGLE SIX-MONTH CONSTRUCTION PROJECT, AFTER WHICH TIME
THE SOILS ARE RETURNED TO EXCAVATION OR ARE TRANSPORTED OFF-SITE.
ASSUMES **NO** CONTROLS ARE USED TO LIMIT RESIDENTIAL EXPOSURE TO SOILS DURING CONSTRUCTION PROJECT.
PROTECTIVE COVER MUST REMAIN OVER SOILS EXCEPT DURING CONSTRUCTION OR UTILITY PROJECT, AFTER WHICH TIME THE PROTECTIVE COVER MUST BE RE-INSTALLED.

Table 2.1
Noncancer Dose-Response Values:
Oral Reference Dose

Chemical Name	CAS Number	Subchronic Oral RfD (mg/kg/day)	Uncertainty/ Modifying Factors	Source	Date Last Checked	Chronic Oral RfD (mg/kg/day)	Uncertainty/ Modifying Factors	Source	Date Last Checked
acenaphthene	83-32-9	2.0E-01		MADEP (6)		6.0E-02		MADEP (6)	
acenaphthylene	208-96-8	3.0E-01		MADEP (6)		3.0E-02		MADEP (6)	
anthracene	120-12-7	1.0E+00		MADEP (6)		3.0E-01		MADEP (6)	
barium	7440-39-3	7.0E-02		MADEP (6)		2.0E-01		MADEP (6)	
benzene	71-43-2	1.0E-02		MADEP (6)		4.0E-03		MADEP (6)	
benzo(a)anthracene	56-55-3	3.0E-01		MADEP (6)		3.0E-02		MADEP (6)	
benzo(a)pyrene	50-32-8	3.0E-01		MADEP (6)		3.0E-02		MADEP (6)	
benzo(b)fluoranthene	205-99-2	3.0E-01		MADEP (6)		3.0E-02		MADEP (6)	
benzo(k)fluoranthene	207-08-9	3.0E-01		MADEP (6)		3.0E-02		MADEP (6)	
benzo(ghi)perylene	191-24-2	3.0E-01		MADEP (6)		3.0E-02		MADEP (6)	
beryllium	7440-41-7	5.0E-03		MADEP (6)		2.0E-03		MADEP (6)	
cadmium	7440-43-9	5.0E-04		MADEP (6)		5.0E-04		MADEP (6)	
chlordan	57-74-9	5.0E-04		MADEP (6)		2.0E-03		MADEP (6)	
chromium (III)	16065-83-1	1.5E+00		MADEP (6)		1.5E+00		MADEP (6)	
chrysene	218-01-9	3.0E-01		MADEP (6)		3.0E-02		MADEP (6)	
dibenzo(a,h)anthracene	53-70-3	3.0E-01		MADEP (6)		3.0E-02		MADEP (6)	
DDT	72-35-9	5.0E-04		MADEP (6)		5.0E-04		MADEP (6)	
DDT	50-29-3	5.0E-04		MADEP (6)		5.0E-04		MADEP (6)	
dieldrin	60-57-1	5.0E-05		MADEP (6)		5.0E-05		MADEP (6)	
dioxin (TCDD equivalents)	1746-01-6	7.0E-10		MADEP (6)		7.0E-10		MADEP (6)	
fluoranthene	206-44-0	4.0E-01		MADEP (6)		4.0E-02		MADEP (6)	
fluorene	86-73-7	4.0E-01		MADEP (6)		4.0E-02		MADEP (6)	
indeno(1,2,3-cd)pyrene	193-39-5	3.0E-01		MADEP (6)		3.0E-02		MADEP (6)	
lead	7439-92-1	7.5E-04		MADEP (6)		7.5E-04		MADEP (6)	
2-methylnaphthalene	91-57-6	4.0E-03		MADEP (6)		4.0E-03		MADEP (6)	
naphthalene	91-20-3	2.0E-01		MADEP (6)		2.0E-02		MADEP (6)	
nickel (soluble salts)	7440-02-0	2.0E-02		MADEP (6)		2.0E-02		MADEP (6)	
phenanthrene	85-01-8	3.0E-01		MADEP (6)		3.0E-02		MADEP (6)	
polychlorinated biphenyls, as PCB-1254	1336-36-3	5.0E-05		MADEP (6)		2.0E-05		MADEP (6)	
pyrene	129-00-0	3.0E-01		MADEP (6)		3.0E-05		MADEP (6)	
thallium	7440-28-0	8.0E-04		MADEP (6)		8.0E-05		MADEP (6)	
toluene	108-88-3	8.0E-01		MADEP (6)		8.0E-02		MADEP (6)	
vanadium	7440-62-2	9.0E-03		MADEP (6)		9.0E-03		MADEP (6)	
zinc	7440-66-6	3.0E-01		MADEP (6)		3.0E-01		MADEP (6)	
C9-C18 Aliphatics	N/A	1.0E+00		MADEP (6)		1.0E-01		MADEP (6)	
C19-C36 Aliphatics	N/A	6.0E+00		MADEP (6)		2.0E+00		MADEP (6)	
C11-C22 Aromatics	N/A	3.0E-01		MADEP (6)		3.0E-02		MADEP (6)	

Notes:

Note 1: For all PAH with no subchronic or chronic RfD, the chronic RfD for naphthalene was used (MADEP(6))
Note 6: Conversion of the inhalation Reference Concentration to an oral Reference Dose, using the equation:

$$RfD = RfC \times \text{Ventilation Rate} / BW = (RfC \times V) / BW = (RfD \times 20 \text{ m}^3/\text{day}) / 70 \text{ kg}$$

MADEP = Massachusetts Department of Environmental Protection
mg/kg/day = milligrams per kilogram body weight per day
N/A = Not available

Reference:

MADEP(6) = Dose response values updated from MADEP's Excel Workbook: Toxicity Values used to derive MCP Method 1 Numerical Standards (6/2014)
(C = SC) = the Chronic Oral RfD was adopted as the Subchronic Oral RfD

Table 2.2
Noncancer Dose-Response Values:
Inhalation Reference Concentrations

Chemical Name	CAS Number	Subchronic Inhalation RfC (mg/cu m)	Uncertainty/ Modifying Factors	Source	Date Last Checked	Chronic Inhalation RfC (mg/cu m)	Uncertainty/ Modifying Factors	Source	Date Last Checked
acenaphthene	83-32-9	5.0E-01		MADEP(5)		5.0E-02		MADEP(5)	
acenaphthylene	208-96-8	5.0E-01		MADEP(5)		5.0E-02		MADEP(5)	
anthracene	120-12-7	5.0E-01		MADEP(5)		5.0E-02		MADEP(5)	
barium	7440-39-3	5.0E-03		MADEP(5)		5.0E-04		MADEP(5)	
benzene	71-43-2	1.0E-02		MADEP(5)		1.0E-02		MADEP(5)	
benzo(a)anthracene	56-55-3	5.0E-01		MADEP(5)		5.0E-02		MADEP(5)	
benzo(a)pyrene	50-32-8	5.0E-01		MADEP(5)		5.0E-02		MADEP(5)	
benzo(b)fluoranthene	205-99-2	5.0E-01		MADEP(5)		5.0E-02		MADEP(5)	
benzo(k)fluoranthene	207-08-9	5.0E-01		MADEP(5)		5.0E-02		MADEP(5)	
benzo(ghi)perylene	191-24-2	5.0E-01		MADEP(5)		5.0E-02		MADEP(5)	
beryllium	7440-41-7	2.0E-05		MADEP(5)		2.0E-05		MADEP(5)	
cadmium	7440-43-9	2.0E-05		MADEP(5)		2.0E-05		MADEP(5)	
chlordan	57-74-9	7.0E-03		MADEP(5)		7.0E-04		MADEP(5)	
chromium (III) (as metal)	16065-83-1	3.0E-04		MADEP(5)		1.0E-04		MADEP(5)	
chrysene	218-01-9	5.0E-01		MADEP(5)		5.0E-02		MADEP(5)	
dibenz(a,h)anthracene	53-70-3	5.0E-01		MADEP(5)		5.0E-02		MADEP(5)	
DDE	72-55-9	1.8E-03		MADEP(5)		1.8E-03		MADEP(5)	
DDT	50-29-3	1.8E-03		MADEP(5)		1.8E-03		MADEP(5)	
dieldrin	60-57-1	1.8E-04		MADEP(5)		1.8E-04		MADEP(5)	
dioxin (TCDD equivalents)	1746-01-6			MADEP(5)				MADEP(5)	
fluoranthene	206-44-0	5.0E-01		MADEP(5)		5.0E-02		MADEP(5)	
fluorene	86-73-7	5.0E-01		MADEP(5)		5.0E-02		MADEP(5)	
indeno(1,2,3-cd)pyrene	193-39-3	5.0E-01		MADEP(5)		5.0E-02		MADEP(5)	
lead	7439-92-1	1.0E-03		MADEP(5)		1.0E-03		MADEP(5)	
2-methylnaphthalene	91-57-6	5.0E-01		MADEP(5)		5.0E-02		MADEP(5)	
naphthalene	91-20-3	3.0E-03		MADEP(5)		3.0E-03		MADEP(5)	
nickel	7440-02-0	1.0E-03		MADEP(5)		1.0E-03		MADEP(5)	
phenanthrene	85-01-8	5.0E-01		MADEP(5)		5.0E-02		MADEP(5)	
polychlorinated biphenyls	1336-36-3	2.0E-05		MADEP(5)		2.0E-05		MADEP(5)	
pyrene	129-00-0	5.0E-01		MADEP(5)		5.0E-02		MADEP(5)	
thallium	7440-28-0	1.4E-05		MADEP(5)		1.4E-05		MADEP(5)	
toluene	108-88-3	5.0E+00		MADEP(5)		5.0E+00		MADEP(5)	
vanadium	7440-62-2	1.0E-03		MADEP(5)		1.0E-03		MADEP(5)	
zinc	7440-66-6	1.4E-03		MADEP(5)		1.4E-03		MADEP(5)	
C9-C18 Aliphatics	N/A	6.0E-01		MADEP(5)		2.0E-01		MADEP(5)	
C19-C36 Aliphatics	N/A	6.0E-01		Note 2		2.0E-01		Note 2	
C11-C22 Aromatics	N/A	5.0E-01		MADEP(5)		5.0E-02		MADEP(5)	

Notes:

Note 1: For PAHs with no RfCs, the chronic RfC for naphthalene was used as a surrogate
Note 2: For C19-C36 aliphatics, the chronic RfC for C9-C18 aliphatics was used as a surrogate
Note 3: Conversion of the oral Reference Dose to an inhalation Reference Concentration, using the equation:
 $RfC = RfD \times BW / \text{Ventilation Rate} = (RfD \times BW) / V = (RfD \times 70 \text{ kg}) / 20 \text{ m}^3/\text{day}$
MADEP = Massachusetts Department of Environmental Protection
mg/cu m = milligrams per cubic meter of air

References:

MADEP(5) = Toxicity Spreadsheet and reference page for in excel workbook "Development of MCP Risk-Based Levels for Soil and Groundwater" (6/2014)
(C = SC) = the Chronic Inhalation RfC was adopted as the Subchronic Inhalation RfC

Table 2.3
Relative Absorption Factors: Non-Cancer

Chemical Name	CAS Number	Soil Ingestion RAF	Water Ingestion RAF	Soil Dermal RAF	Water Dermal RAF
acenaphthene	83-32-9	0.3	1	0.1	1
acenaphthylene	208-96-8	0.3	1	0.1	1
anthracene	120-12-7	0.3	1	0.1	1
barium	7440-39-3	1	1	0.1	1
benzene	71-43-2	1	1	0.03	1
benzo(a)anthracene	56-55-3	0.3	1	0.02	1
benzo(a)pyrene	50-32-8	0.3	1	0.02	1
benzo(b)fluoranthene	205-99-2	0.3	1	0.02	1
benzo(k)fluoranthene	207-08-9	0.3	1	0.02	1
benzo(ghi)perylene	191-24-2	0.3	1	0.1	1
beryllium	7440-41-7	1	1	0.1	1
cadmium	7440-43-9	0.5	1	0.01	1
chlordane	57-74-9	1	1	0.04	1
chromium (III)	16065-83-1	1	1	0.1	1
chrysene	218-01-9	0.3	1	0.02	1
dibenzo(a,h)anthracene	53-70-3	0.3	1	0.02	1
DDD	72-54-8	1	1	0.2	1
DDE	72-55-9	1	1	0.03	1
DDT	50-29-3	1	1	0.03	1
dieldrin	60-57-1	1	1	0.1	1
dioxin (TCDD equivalent)	1746-01-6	1	1	0.1	1
fluoranthene	206-44-0	0.3	1	0.1	1
fluorene	86-73-7	0.3	1	0.1	1
indeno(1,23-cd)pyrene	193-39-5	0.3	1	0.02	1
lead	7439-92-1	0.5	1	0.006	1
2-methylnaphthalene	91-57-6	0.3	1	0.1	1
naphthalene	91-20-3	0.3	1	0.1	1
nickel	7440-02-0	1	1	0.2	1
phenanthrene	85-01-8	0.3	1	0.1	1
polychlorinated biphenyls	1336-36-3	1	1	0.1	1
pyrene	129-00-0	0.3	1	0.1	1
thallium	7440-28-0	1	1	0.01	1
toluene	108-88-3	1	1	0.03	1
vanadium	7440-62-2	1	1	0.1	1
zinc	7440-66-6	1	1	0.1	1
C9-C18 Aliphatics	N/A	1	1	0.2	1
C19-C36 Aliphatics	N/A	1	1	0.2	1
C11-C22 Aromatics	N/A	0.3	1	0.1	1

Notes:

(1) A default value of one (1) was assigned to dermal contact with water.

References:

MADEP, 2014. Dose response values updated from MADEP's Excel Workbook: Toxicity Values used to derive MCP Method 1 Numerical Standards (6/2014)

Table 1.1
Soil Exposure Point Concentrations and Soil Concentrations used to Derive Dust Exposure Point Concentrations

Chemical Name	CAS Number	Courtyard 0-1 Foot Interval	Courtyard 1-3 Foot Interval	Courtyard 3-6 Foot Interval	Courtyard 3-11 Foot Interval	Stockpiled Fuel Oil Vault Sands SP-3
acenaphthene	83-32-9	8.6E-01	8.6E-01	3.8E-01	3.3E-01	7.0E-01
acenaphthylene	208-96-8	2.3E-01	2.3E-01	8.4E-02	9.6E-02	9.0E-02
anthracene	120-12-7	1.9E+00	1.9E+00	8.4E-01	7.5E-01	1.5E+00
barium	7440-39-3	1.07E+02	9.20E+01	4.90E+01	4.90E+01	1.04E+02
benzene	71-43-2			5.3E-02	5.3E-02	
benzo(a)anthracene	56-55-3	4.3E+00	4.3E+00	1.8E+00	1.6E+00	3.0E+00
benzo(a)pyrene	50-32-8	3.9E+00	3.9E+00	1.6E+00	1.5E+00	2.6E+00
benzo(b)fluoranthene	205-99-2	5.1E+00	5.1E+00	2.2E+00	2.0E+00	3.5E+00
benzo(k)fluoranthene	207-08-9	1.8E+00	1.8E+00	8.3E-01	7.7E-01	1.4E+00
benzo(ghi)perylene	191-24-2	2.2E+00	2.2E+00	9.1E-01	8.5E-01	1.4E+00
beryllium	7440-41-7	5.1E+00	9.2E+00	1.9E+00	1.9E+00	9.3E-01
chlordane	57-74-9			1.3E-01	1.3E-01	
chromium (III)	16065-83-1	3.6E+01	3.7E+01	1.7E+01	1.7E+01	3.4E+01
chrysene	218-01-9	4.8E+00	4.8E+00	1.9E+00	1.8E+00	2.8E+00
dibenzo(a,h)anthracene	53-70-3	6.5E-01	6.5E-01	2.5E-01	2.4E-01	5.9E-01
DDE	72-55-9	5.4E-02	4.7E-02			
DDT	50-29-3	1.0E-01	6.8E-02	3.7E-02	3.7E-02	1.1E-01
dieldrin	60-57-1	1.1E-01	4.7E-02	3.2E-02	3.2E-02	1.7E-01
dioxin (TCDD equivalents)	1746-01-6	1.4E-04	2.5E-05	6.3E-06	6.6E-06	4.3E-05
fluoranthene	206-44-0	9.9E+00	9.9E+00	4.0E+00	3.7E+00	7.0E+00
fluorene	86-73-7	8.9E-01	8.9E-01	4.1E-01	3.7E-01	9.3E-01
indeno(123-cd)pyrene	193-39-5	2.5E+00	2.5E+00	9.7E-01	8.9E-01	1.4E+00
lead	7439-92-1	4.36E+02	3.66E+02	1.05E+02	1.04E+02	4.21E+02
2-methylnaphthalene	91-57-6	3.3E-01	3.3E-01	1.3E-01	1.7E-01	2.9E-01
naphthalene	91-20-3	7.5E-01	7.5E-01	1.8E-01	2.0E-01	5.9E-01
nickel (soluble salts)	7440-02-0	3.4E+01	4.0E+01	2.4E+01	2.4E+01	2.5E+01
phenanthrene	85-01-8	7.9E+00	7.9E+00	3.4E+00	3.1E+00	5.9E+00
polychlorinated biphenyls, as						
PCB-1254	1336-36-3	4.1E+01	7.6E+00	1.9E+00	2.0E+00	1.3E+01
pyrene	129-00-0	9.6E+00	9.6E+00	3.7E+00	3.4E+00	5.0E+00
thallium	7440-28-0					3.5E+00
toluene	108-88-3			2.1E-01	2.1E-01	
vanadium	7440-62-2	3.7E+02	4.4E+02	1.5E+02	1.8E+02	1.1E+02
zinc	7440-66-6	1.9E+02	1.8E+02	9.4E+01	9.4E+01	1.6E+02
C9-C18 Aliphatics	N/A	4.40E+01	4.40E+01	1.20E+01	3.10E+01	
C19-C36 Aliphatics	N/A	1.79E+02	1.79E+02	4.70E+01	9.30E+01	
C11-C22 Aromatics	N/A	2.97E+02	2.97E+02	9.80E+01	1.79E+02	

unit, milligram per kilogram (mg/kg), ppm

Abbreviations:

Table 1.2
Exposure Point Concentrations for Dust

Chemical Name	CAS Number	Courtyard 0-1 Foot Interval	Courtyard 1-3 Foot Interval	Courtyard 3-6 Foot Interval	Courtyard 3-11 Foot Interval	Stockpiled Fuel Oil Vault Sands SP-3	0.00	0.00
acenaphthene	83-32-9	5.16E-05	5.16E-05	2.28E-05	1.98E-05	4.20E-05		
acenaphthylene	208-96-8	1.38E-05	1.38E-05	5.04E-06	5.76E-06	5.40E-06		
anthracene	120-12-7	1.14E-04	1.14E-04	5.04E-05	4.50E-05	9.00E-05		
barium	7440-39-3	6.42E-03	5.52E-03	2.94E-03	2.94E-03	6.24E-03		
benzene	71-43-2			3.18E-06	3.18E-06			
benzo(a)anthracene	56-55-3	2.58E-04	2.58E-04	1.08E-04	9.60E-05	1.80E-04		
benzo(a)pyrene	50-32-8	2.34E-04	2.34E-04	9.60E-05	9.00E-05	1.56E-04		
benzo(b)fluoranthene	205-99-2	3.06E-04	3.06E-04	1.32E-04	1.20E-04	2.10E-04		
benzo(k)fluoranthene	207-08-9	1.08E-04	1.08E-04	4.98E-05	4.62E-05	8.40E-05		
benzo(ghi)perylene	191-24-2	1.32E-04	1.32E-04	5.46E-05	5.10E-05	8.40E-05		
beryllium	7440-41-7	3.06E-04	5.52E-04	1.14E-04	1.14E-04	5.58E-05		
chlordane	57-74-9			7.80E-06	7.80E-06			
chromium (III)	16065-83-1	2.16E-03	2.22E-03	1.02E-03	1.02E-03	2.04E-03		
chrysene	218-01-9	2.88E-04	2.88E-04	1.14E-04	1.08E-04	1.68E-04		
dibenzo(a,h)anthracene	53-70-3	3.90E-05	3.90E-05	1.50E-05	1.44E-05	3.54E-05		
DDE	72-55-9	3.24E-06	2.82E-06					
DDT	50-29-3	6.12E-06	4.08E-06	2.22E-06	2.22E-06	6.60E-06		
dieldrin	60-57-1	6.48E-06	2.82E-06	1.92E-06	1.92E-06	1.02E-05		
dioxin (TCDD equivalents)	1746-01-6	8.10E-09	1.51E-09	3.76E-10	3.96E-10	2.57E-09		
fluoranthene	206-44-0	5.94E-04	5.94E-04	2.40E-04	2.22E-04	4.20E-04		
fluorene	86-73-7	5.34E-05	5.34E-05	2.46E-05	2.22E-05	5.58E-05		
indeno(123-cd)pyrene	193-39-5	1.50E-04	1.50E-04	5.82E-05	5.34E-05	8.40E-05		
lead	7439-92-1	2.62E-02	2.20E-02	6.30E-03	6.24E-03	2.53E-02		
2-methylnaphthalene	91-57-6	1.98E-05	1.98E-05	7.80E-06	1.02E-05	1.74E-05		
naphthalene	91-20-3	4.50E-05	4.50E-05	1.08E-05	1.20E-05	3.54E-05		
nickel (soluble salts)	7440-02-0	2.04E-03	2.40E-03	1.44E-03	1.44E-03	1.50E-03		
phenanthrene	85-01-8	4.74E-04	4.74E-04	2.04E-04	1.86E-04	3.54E-04		
polychlorinated biphenyls, as PCB-1254	1336-36-3	2.46E-03	4.56E-04	1.14E-04	1.20E-04	7.80E-04		
pyrene	129-00-0	5.76E-04	5.76E-04	2.22E-04	2.04E-04	3.00E-04		
thallium	7440-28-0					2.10E-04		
toluene	108-88-3			1.26E-05	1.26E-05			
vanadium	7440-62-2	2.23E-02	2.66E-02	9.06E-03	1.07E-02	6.42E-03		
zinc	7440-66-6	1.13E-02	1.05E-02	5.64E-03	5.64E-03	9.66E-03		
C9-C18 Aliphatics	N/A	2.64E-03	2.64E-03	7.20E-04	1.86E-03			
C19-C36 Aliphatics	N/A	1.07E-02	1.07E-02	2.82E-03	5.58E-03			
C11-C22 Aromatics	N/A	1.78E-02	1.78E-02	5.88E-03	1.07E-02			

Formula:

$$\text{EPC-air} = [\text{OHM}]\text{-soil} * \text{PF} * \text{PM-10} * \text{CF}$$

where,

EPC-air = Exposure Point Concentration (ug/cu m)

[OHM]-soil = soil concentration (mg/kg)

PM-10 = respirable particulate concentration in air (60 ug/cu m)

PF = proportion of respirable particulate concentrations attributable to the site (1.0)

CF = conversion factor (1E-06 kg/ug)

Units:

Soil EPC = mg/kg

Dust EPC = ug/cu m

Refer to Table 6.4 for Soil Concentrations used to derive Dust Exposure Point Concentrations

Table 3.1
Calculation of Average Daily Dose for Soil Exposure: Child Resident, aged 1 Year

Receptor: Child Resident, aged 1 year													
Exposure Point:		Courtyard 0-1 Foot Interval		Courtyard 1-3 Foot Interval		Courtyard 3-6 Foot Interval		Courtyard 3-11 Foot Interval		Stockpiled Fuel Oil Vault Sands SP-3		0.00E+00	
Chemical Name	CAS Number	Dermal Contact	Incidental Ingestion	Dermal Contact	Incidental Ingestion	Dermal Contact	Incidental Ingestion	Dermal Contact	Incidental Ingestion	Dermal Contact	Incidental Ingestion	Dermal Contact	Incidental Ingestion
acenaphthene	83-32-9	2.34E-06	1.20E-06	2.34E-06	1.20E-06	1.04E-06	5.31E-07	8.99E-07	4.61E-07	1.91E-06	9.79E-07		
acenaphthylene	208-96-8	6.26E-07	3.22E-07	6.26E-07	3.22E-07	2.29E-07	1.17E-07	2.61E-07	1.34E-07	2.45E-07	1.26E-07		
anthracene	120-12-7	5.18E-06	2.66E-06	5.18E-06	2.66E-06	2.29E-06	1.17E-06	2.04E-06	1.05E-06	4.09E-06	2.10E-06		
barium	7440-39-3	2.91E-04	4.99E-04	2.51E-04	4.29E-04	1.33E-04	2.28E-04	1.33E-04	2.28E-04	2.83E-04	4.85E-04		
benzene	71-43-2					4.33E-08	2.47E-07	4.33E-08	2.47E-07				
benzo(a)anthracene	56-55-3	2.34E-06	6.01E-06	2.34E-06	6.01E-06	9.81E-07	2.52E-06	8.72E-07	2.24E-06	1.63E-06	4.19E-06		
benzo(a)pyrene	50-32-8	2.12E-06	5.45E-06	2.12E-06	5.45E-06	8.72E-07	2.24E-06	8.17E-07	2.10E-06	1.42E-06	3.63E-06		
benzo(b)fluoranthene	205-99-2	2.78E-06	7.13E-06	2.78E-06	7.13E-06	1.20E-06	3.08E-06	1.09E-06	2.80E-06	1.91E-06	4.89E-06		
benzo(k)fluoranthene	207-08-9	9.81E-07	2.52E-06	9.81E-07	2.52E-06	4.52E-07	1.16E-06	4.19E-07	1.08E-06	7.63E-07	1.96E-06		
benzo(ghi)perylene	191-24-2	5.99E-06	3.08E-06	5.99E-06	3.08E-06	2.48E-06	1.27E-06	2.32E-06	1.19E-06	3.81E-06	1.96E-06		
beryllium	7440-41-7	1.39E-05	2.38E-05	2.51E-05	4.29E-05	5.18E-06	8.85E-06	5.18E-06	8.85E-06	2.53E-06	4.33E-06		
chlordan	57-74-9					1.42E-07	6.06E-07	1.42E-07	6.06E-07				
chromium (III)	16065-83-1	9.81E-05	1.68E-04	1.01E-04	1.72E-04	4.63E-05	7.92E-05	4.63E-05	7.92E-05	9.26E-05	1.38E-04		
chrysene	218-01-9	2.61E-06	6.71E-06	2.61E-06	6.71E-06	1.04E-06	2.66E-06	9.81E-07	2.52E-06	1.53E-06	3.91E-06		
dibenzo(a,h)anthracene	53-70-3	3.54E-07	9.09E-07	3.54E-07	9.09E-07	1.36E-07	3.50E-07	1.31E-07	3.36E-07	3.21E-07	8.25E-07		
DDE	72-55-9	4.41E-08	2.52E-07	3.84E-08	2.19E-07								
DDT	50-29-3	8.33E-08	4.75E-07	5.56E-08	3.17E-07	3.02E-08	1.72E-07	3.02E-08	1.72E-07	8.99E-08	5.13E-07		
dieldrin	60-57-1	2.94E-07	5.03E-07	1.28E-07	2.19E-07	8.72E-08	1.49E-07	8.72E-08	1.49E-07	4.63E-07	7.92E-07		
dioxin (TCDD equivalents)	1746-01-6	3.68E-10	6.29E-10	6.84E-11	1.17E-10	1.71E-11	2.92E-11	1.80E-11	3.08E-11	1.17E-10	2.00E-10		
fluoranthene	206-44-0	2.70E-05	1.38E-05	2.70E-05	1.38E-05	1.09E-05	5.59E-06	1.01E-05	5.17E-06	1.91E-05	9.79E-06		
fluorene	86-73-7	2.42E-06	1.24E-06	2.42E-06	1.24E-06	1.12E-06	5.73E-07	1.01E-06	5.17E-07	2.53E-06	1.30E-06		
indeno(1,23-cd)pyrene	193-39-5	1.36E-06	3.50E-06	1.36E-06	3.50E-06	5.28E-07	1.36E-06	4.85E-07	1.24E-06	7.63E-07	1.96E-06		
lead	7439-92-1	7.13E-05	1.02E-03	5.98E-05	8.53E-04	1.72E-05	2.45E-04	1.70E-05	2.42E-04	6.88E-05	9.81E-04		
2-methylnaphthalene	91-57-6	8.99E-07	4.61E-07	8.99E-07	4.61E-07	3.54E-07	1.82E-07	4.63E-07	2.38E-07	7.90E-07	4.05E-07		
naphthalene	91-20-3	2.04E-06	1.05E-06	2.04E-06	1.05E-06	4.90E-07	2.52E-07	5.45E-07	2.80E-07	1.61E-06	8.25E-07		
nickel (soluble salts)	7440-02-0	1.85E-04	1.58E-04	2.18E-04	1.86E-04	1.31E-04	1.12E-04	1.31E-04	1.12E-04	1.36E-04	1.17E-04		
phenanthrene	85-01-8	2.15E-05	1.10E-05	2.15E-05	1.10E-05	9.26E-06	4.75E-06	8.44E-06	4.33E-06	1.61E-05	8.25E-06		
polychlorinated biphenyls, as PCB-1254	1336-36-3	1.12E-04	1.91E-04	2.07E-05	3.54E-05	5.18E-06	8.85E-06	5.45E-06	9.32E-06	3.54E-05	6.06E-05		
pyrene	129-00-0	2.61E-05	1.34E-05	2.61E-05	1.34E-05	1.01E-05	5.17E-06	9.26E-06	4.75E-06	1.36E-05	6.99E-06		
thallium	7440-28-0									9.53E-07	1.63E-05		
toluene	108-88-3					1.72E-07	9.79E-07	1.72E-07	9.79E-07				
vanadium	7440-62-2	1.01E-03	1.73E-03	1.21E-03	2.06E-03	4.11E-04	7.04E-04	4.85E-04	8.59E-04	2.91E-04	4.99E-04		
zinc	7440-66-6	5.12E-04	8.76E-04	4.77E-04	8.16E-04	2.56E-04	4.38E-04	2.56E-04	4.38E-04	4.39E-04	7.50E-04		
C9-C18 Aliphatics	N/A	2.40E-04	2.05E-04	2.40E-04	2.05E-04	6.54E-05	5.59E-05	1.69E-04	1.44E-04				
C19-C36 Aliphatics	N/A	9.75E-04	8.34E-04	9.75E-04	8.34E-04	2.56E-04	2.19E-04	5.07E-04	4.33E-04				
C11-C22 Aromatics	N/A	8.09E-04	4.15E-04	8.09E-04	4.15E-04	2.67E-04	1.37E-04	4.88E-04	2.50E-04				

Table 3.1
Calculation of Average Daily Dose for Soil Exposure: Child Resident, aged 1 Year

Formula: Daily Dose (ADD) for exposure to soils via ingestion (ing) and dermal contact							
<div>ADD-dermal = $\frac{[\text{OHM-soil}] * \text{SA} * \text{AF} * \text{RAF} * \text{EF} * \text{ED} * \text{EP} * \text{C}}{\text{BW} * \text{AP}}$</div> <div>ADD-ing = $\frac{[\text{OHM-soil}] * \text{IR} * \text{RAF} * \text{EF} * \text{ED} * \text{EP} * \text{C}}{\text{BW} * \text{AP}}$</div>					<div>Unit:</div> <div>ADD, mg/kg/day</div>		
Receptor: Child Resident, aged 1 to 8 years (Chronic) and aged 1 year (Subchronic)							
Description	Abbreviation	Unit	Default Value	Source	Site-Specific Value	Source / Description	Input Value
Exposure point concentration	[OHM-soil]	mg/kg			See Soil EPC Table		See Soil EPC Table
Skin surface area in contact with soil on days exposed	SA	square centimeter/day	2431	[2], child, aged 1 to 8 years (face, hands, forearms, lower legs and feet)	1670	child, aged 1 to 2 years (face, hands, forearms, lower legs and feet)	1.67E+03
Mass of soil adhered to the unit surface area of skin exposed	AF	mg/sq. cm.	0.35	[1], for child resident			3.50E-01
Relative Absorption Factor	RAF	unitless	See RAF Table				See RAF Table
# exposure events during EP / # days in EP	EF	events/year	150	[2], 5 days per week during the 30 warmest weeks of the year	182	Seven days per week during a six-month construction project	1.82E+02
Exposure duration: typical duration of each exposure event	ED	years/event	2.74E-03	1 day per event or 1/365 of a year per event			2.74E-03
Exposure period: period of time over which exposure may occur	EP	years	7	[2], child, aged 1 to 8 years	1.0	subchronic exposure of 1 year old boy or girl (Subchronic)	1.00E+00
Unit Conversion Factor	C	kg/mg	1.00E-06	for dermal contact			1.00E-06
Unit Conversion Factor	C	kg/mg	1.00E-06	for ingestion			1.00E-06
Body weight of the receptor during the AP	BW	kg	17	[2], child, aged 1 to 8 years	1.07E+01	subchronic exposure of 1 year old boy or girl	1.07E+01
Averaging Period	AP	years	7	[2]	1.0	subchronic exposure of 1 year old boy or girl	1.00E+00
Ingestion rate	IR	mg/day	100	[2]			1.00E+02

References:

- [1] MADEP's Technical Update, Weighted Skin-Soil Adherence Factors, April 2002.
- [2] MADEP's Guidance for Disposal Site Risk Characterization in Support of the Massachusetts Contingency Plan, Interim Final Policy BWSC/ORS-95-141

Table 3.2
Calculation of Average Daily Exposure for Dust: Child Resident, aged 1

Receptor: Child Resident, aged 1 year								
Chemical Name	CAS Number	Courtyard 0-1 Foot Interval	Courtyard 1-3 Foot Interval	Courtyard 3-6 Foot Interval	Courtyard 3- 11 Foot Interval	Stockpiled Fuel Oil Vault Sands SP-3	0.00	0.00
acenaphthene	83-32-9	2.6E-08	2.6E-08	1.1E-08	9.9E-09	2.1E-08		
acenaphthylene	208-96-8	6.9E-09	6.9E-09	2.5E-09	2.9E-09	2.7E-09		
anthracene	120-12-7	5.7E-08	5.7E-08	2.5E-08	2.2E-08	4.5E-08		
barium	7440-39-3	3.2E-06	2.8E-06	1.5E-06	1.5E-06	3.1E-06		
benzene	71-43-2			1.6E-09	1.6E-09			
benzo(a)anthracene	56-55-3	1.3E-07	1.3E-07	5.4E-08	4.8E-08	9.0E-08		
benzo(a)pyrene	50-32-8	1.2E-07	1.2E-07	4.8E-08	4.5E-08	7.8E-08		
benzo(b)fluoranthene	205-99-2	1.5E-07	1.5E-07	6.6E-08	6.0E-08	1.0E-07		
benzo(k)fluoranthene	207-08-9	5.4E-08	5.4E-08	2.5E-08	2.3E-08	4.2E-08		
benzo(ghi)perylene	191-24-2	6.6E-08	6.6E-08	2.7E-08	2.5E-08	4.2E-08		
beryllium	7440-41-7	1.5E-07	2.8E-07	5.7E-08	5.7E-08	2.8E-08		
chlordane	57-74-9			3.9E-09	3.9E-09			
chromium (III)	16065-83-1	1.1E-06	1.1E-06	5.1E-07	5.1E-07	1.0E-06		
chrysene	218-01-9	1.4E-07	1.4E-07	5.7E-08	5.4E-08	8.4E-08		
dibenz(a,h)anthracene	53-70-3	1.9E-08	1.9E-08	7.5E-09	7.2E-09	1.8E-08		
DDE	72-55-9	1.6E-09	1.4E-09					
DDT	50-29-3	3.1E-09	2.0E-09	1.1E-09	1.1E-09	3.3E-09		
dieldrin	60-57-1	3.2E-09	1.4E-09	9.6E-10	9.6E-10	5.1E-09		
dioxin (TCDD equivalents)	1746-01-6	4.0E-12	7.5E-13	1.9E-13	2.0E-13	1.3E-12		
fluoranthene	206-44-0	3.0E-07	3.0E-07	1.2E-07	1.1E-07	2.1E-07		
fluorene	86-73-7	2.7E-08	2.7E-08	1.2E-08	1.1E-08	2.8E-08		
indeno(123-cd)pyrene	193-39-5	7.5E-08	7.5E-08	2.9E-08	2.7E-08	4.2E-08		
lead	7439-92-1	1.3E-05	1.1E-05	3.1E-06	3.1E-06	1.3E-05		
2-methylnaphthalene	91-57-6	9.9E-09	9.9E-09	3.9E-09	5.1E-09	8.7E-09		
naphthalene	91-20-3	2.2E-08	2.2E-08	5.4E-09	6.0E-09	1.8E-08		
nickel (soluble salts)	7440-02-0	1.0E-06	1.2E-06	7.2E-07	7.2E-07	7.5E-07		
phenanthrene	85-01-8	2.4E-07	2.4E-07	1.0E-07	9.3E-08	1.8E-07		
polychlorinated biphenyls, as PCB-1254	1336-36-3	1.2E-06	2.3E-07	5.7E-08	6.0E-08	3.9E-07		
pyrene	129-00-0	2.9E-07	2.9E-07	1.1E-07	1.0E-07	1.5E-07		
thallium	7440-28-0					1.0E-07		
toluene	108-88-3			6.3E-09	6.3E-09			
vanadium	7440-62-2	1.1E-05	1.3E-05	4.5E-06	5.3E-06	3.2E-06		
zinc	7440-66-6	5.6E-06	5.2E-06	2.8E-06	2.8E-06	4.8E-06		
C9-C18 Aliphatics	N/A	1.3E-06	1.3E-06	3.6E-07	9.3E-07			
C19-C36 Aliphatics	N/A	5.4E-06	5.4E-06	1.4E-06	2.8E-06			
C11-C22 Aromatics	N/A	8.9E-06	8.9E-06	2.9E-06	5.4E-06			

Table 3.2
Calculation of Average Daily Exposure for Dust: Child Resident, aged 1

Formula: Average Daily Exposure (ADE) via inhalation (ihl) of dusts							
ADE-ihl = $\frac{[\text{OHM-dust}] * \text{EF} * \text{ED} * \text{EP} * \text{C}}{\text{AP}}$				Unit:		ADE, mg/cu m	
Receptor: Child Resident, aged 1 to 8 years (Chronic) and aged 1 year (Subchronic)							
Description	Abbreviation	Unit	Default Value	Source	Site-Specific Value	Source / Description	Input Value
Exposure point concentration	[OHM-dust]	ug/cu. m.			See Dust EPC Table		See Dust EPC Table
Exposure frequency: # exposure events during EP / # days in EP	EF	events/year	150	[2], 5 days per week during the 30 warmest weeks of the year	182	Seven days per week during a six-month construction project	1.82E+02
Exposure duration: typical duration of each exposure event	ED	years/event	2.74E-03	1 day per event, or 1/365 of a year per event			2.74E-03
Exposure period: period of time over which exposure may occur	EP	years	7	[1], from age 1 to 8 years	1.00E+00	subchronic exposure of 1 year old boy or girl	1.00E+00
Unit Conversion Factor	C	mg/ug	1.00E-03	for inhalation			1.00E-03
Averaging Period	AP	years	7	[1]	1.00E+00	subchronic exposure of 1 year old boy or girl	1.00E+00

References:

[1] MADEP's Guidance for Disposal Site Risk Characterization in Support of the Massachusetts Contingency Plan, Interim Final Policy BWSC/ORS-95-141

Table 4.1
Calculation of Hazard Index (HI) for Exposure to Soil and Dust: Child Resident, aged 1 Year

Receptor: Child Resident, aged 1 year																
Exposure Point:		Courtyard 0-1 Foot Interval			Courtyard 1-3 Foot Interval			Courtyard 3-6 Foot Interval			Courtyard 3-11 Foot Interval			Stockpiled Fuel Oil Vault Sands SP-3		
Chemical Name	CAS Number	Dermal Contact	Incidental Ingestion	Dust Inhalation	Dermal Contact	Incidental Ingestion	Dust Inhalation	Dermal Contact	Incidental Ingestion	Dust Inhalation	Dermal Contact	Incidental Ingestion	Dust Inhalation	Dermal Contact	Incidental Ingestion	Dust Inhalation
acenaphthene	83-32-9	1.2E-05	6.0E-06	5.1E-08	1.2E-05	6.0E-06	5.1E-08	5.2E-06	2.7E-06	2.3E-08	4.5E-06	2.3E-06	2.0E-08	9.5E-06	4.9E-06	4.2E-08
acenaphthylene	208-96-8	2.1E-06	1.1E-06	1.4E-08	2.1E-06	1.1E-06	1.4E-08	7.6E-07	3.9E-07	5.0E-09	8.7E-07	4.3E-07	5.7E-09	8.2E-07	4.2E-07	3.4E-09
anthracene	120-12-9	5.2E-06	2.7E-06	1.1E-07	5.2E-06	2.7E-06	1.1E-07	2.3E-06	1.2E-06	5.0E-08	2.0E-06	1.0E-06	4.3E-08	4.1E-06	2.1E-06	9.0E-08
barium	7440-39-3	4.2E-03	7.1E-03	6.4E-04	3.6E-03	6.1E-03	5.5E-04	1.9E-03	3.3E-03	2.9E-04	1.9E-03	3.3E-03	2.9E-04	4.0E-03	6.9E-03	6.2E-04
benzene	71-43-2	7.8E-06	2.0E-05	2.6E-07	7.8E-06	2.0E-05	2.6E-07	4.3E-06	2.5E-05	1.6E-07	4.3E-06	2.5E-05	1.6E-07	4.3E-06	2.5E-05	1.6E-07
benzo(a)anthracene	56-55-3	7.8E-06	2.0E-05	2.6E-07	7.8E-06	2.0E-05	2.6E-07	3.3E-06	8.4E-06	1.1E-07	2.9E-06	7.5E-06	9.6E-08	5.4E-06	1.4E-05	1.8E-07
benzo(a)pyrene	50-32-8	7.1E-06	1.8E-05	2.3E-07	7.1E-06	1.8E-05	2.3E-07	2.9E-06	7.5E-06	9.6E-08	2.7E-06	7.0E-06	9.0E-08	4.7E-06	1.2E-05	1.6E-07
benzo(b)fluoranthene	205-99-2	9.3E-06	2.4E-05	3.1E-07	9.3E-06	2.4E-05	3.1E-07	4.0E-06	1.0E-05	1.3E-07	3.6E-06	9.3E-06	1.2E-07	6.4E-06	1.6E-05	2.1E-07
benzo(k)fluoranthene	207-08-9	3.3E-06	8.4E-06	1.1E-07	3.3E-06	8.4E-06	1.1E-07	1.5E-06	3.9E-06	5.0E-08	1.4E-06	3.6E-06	4.6E-08	2.5E-06	6.5E-06	8.4E-08
benzo(ghi)perylene	191-24-2	2.0E-05	1.0E-05	1.3E-07	2.0E-05	1.0E-05	1.3E-07	8.3E-06	4.2E-06	5.4E-08	7.7E-06	4.0E-06	5.1E-08	1.3E-05	6.5E-06	8.4E-08
beryllium	7440-31-7	2.8E-03	4.8E-03	7.6E-03	3.0E-03	8.6E-03	1.4E-02	1.0E-03	1.8E-03	2.8E-03	1.0E-03	1.8E-03	2.8E-03	3.1E-04	8.7E-04	1.4E-03
chloroform	59-74-9	6.5E-05	1.1E-04	3.6E-03	6.7E-05	1.1E-04	3.7E-03	2.8E-04	1.2E-03	5.6E-07	2.8E-04	1.2E-03	5.6E-07	2.8E-04	1.2E-03	5.6E-07
chromium (III)	16083-83-1	6.5E-05	1.1E-04	3.6E-03	6.7E-05	1.1E-04	3.7E-03	3.1E-05	8.3E-05	1.7E-03	3.1E-05	8.3E-05	1.7E-03	6.2E-05	1.1E-04	3.4E-03
chrysene	218-01-9	8.7E-06	2.2E-05	2.9E-07	8.7E-06	2.2E-05	2.9E-07	3.5E-06	8.9E-06	1.1E-07	3.3E-06	8.4E-06	1.1E-07	5.1E-06	1.3E-05	1.7E-07
dibenz(a,h)anthracene	53-70-3	1.2E-06	3.0E-06	3.9E-08	1.2E-06	3.0E-06	3.9E-08	4.5E-07	1.2E-06	1.3E-08	4.4E-07	1.1E-06	1.4E-08	1.1E-06	2.7E-06	3.5E-08
DDE	72-55-9	8.8E-05	5.0E-04	9.2E-07	7.7E-05	4.4E-04	8.0E-07									
DDT	50-29-3	1.7E-04	9.5E-04	1.7E-06	1.1E-04	6.3E-04	1.2E-06	6.0E-05	3.4E-04	6.3E-07	6.0E-05	3.4E-04	6.3E-07	1.8E-04	1.0E-03	1.9E-06
dieldrin	60-39-1	5.9E-03	1.0E-02	1.8E-05	2.6E-03	4.4E-03	8.0E-06	1.7E-03	3.0E-03	3.3E-06	1.7E-03	3.0E-03	3.3E-06	9.3E-03	1.6E-02	2.9E-05
dioxin (TCDD equivalents)	1746-01-6	5.3E-01	9.0E-01		9.8E-02	1.7E-01		2.4E-02	4.2E-02		2.6E-02	4.4E-02		1.7E-01	2.9E-01	
fluoranthene	206-24-0	6.7E-05	3.5E-05	3.9E-07	6.7E-05	3.5E-05	3.9E-07	2.7E-05	1.4E-05	2.4E-07	2.5E-05	1.3E-05	2.3E-07	4.8E-05	2.4E-05	4.2E-07
fluorene	86-73-7	6.1E-06	3.1E-06	5.3E-08	6.1E-06	3.1E-06	5.3E-08	2.8E-06	1.4E-06	2.5E-08	2.5E-06	1.3E-06	2.3E-08	6.3E-06	3.3E-06	3.6E-08
indeno(1,2,3-cd)pyrene	193-39-3	4.5E-06	1.2E-05	1.3E-07	4.5E-06	1.2E-05	1.3E-07	1.8E-06	4.5E-06	3.8E-08	1.6E-06	4.1E-06	3.3E-08	2.3E-06	6.5E-06	8.4E-08
lead	7439-92-1	9.5E-02	1.4E+00	1.3E-02	8.0E-02	1.1E+00	1.1E-02	2.3E-02	3.3E-01	3.1E-03	2.3E-02	3.3E-01	3.1E-03	9.2E-02	1.3E+00	1.3E-02
2-methylnaphthalene	91-57-6	2.2E-04	1.2E-04	2.0E-08	2.2E-04	1.2E-04	2.0E-08	3.9E-05	4.5E-05	7.8E-09	1.2E-04	5.9E-05	1.0E-08	2.0E-04	1.0E-04	1.7E-08
naphthalene	91-20-3	1.0E-05	5.2E-06	7.5E-06	1.0E-05	5.2E-06	7.5E-06	2.5E-06	1.3E-06	1.8E-06	2.7E-06	1.4E-06	2.0E-06	8.0E-06	4.1E-06	5.9E-06
nickel (soluble salts)	7440-02-0	9.3E-03	7.9E-03	1.0E-03	1.1E-02	9.3E-03	1.2E-03	6.5E-03	5.6E-03	7.2E-04	6.5E-03	5.6E-03	7.2E-04	6.8E-03	5.8E-03	7.5E-04
phenanthrene	85-01-8	7.2E-05	3.7E-05	4.7E-07	7.2E-05	3.7E-05	4.7E-07	3.1E-05	1.6E-05	2.0E-07	2.8E-05	1.4E-05	1.9E-07	3.4E-05	2.7E-05	3.3E-07
polychlorinated biphenyls, as PCB-1254	1336-36-3	2.2E+00	3.8E+00	6.1E-02	4.1E-01	7.1E-01	1.1E-02	1.0E-01	1.8E-01	2.8E-03	1.1E-01	1.9E-01	3.0E-03	7.1E-01	1.2E+00	1.9E-02
pyrene	129-00-0	8.9E-05	4.3E-05	3.9E-07	8.7E-05	4.3E-05	3.9E-07	3.4E-05	1.7E-05	2.2E-07	3.1E-05	1.6E-05	2.0E-07	4.3E-05	2.3E-05	3.0E-07
thallium	7440-28-0															
toluene	108-88-3							2.1E-07	1.2E-06	1.3E-09	2.1E-07	1.2E-06	1.3E-09			
vanadium	7440-62-2	1.1E-01	1.9E-01	1.1E-02	1.3E-01	2.3E-01	1.3E-02	4.6E-02	7.8E-02	4.5E-03	5.4E-02	9.2E-02	5.3E-03	3.2E-02	5.5E-02	3.2E-03
zinc	7440-66-6	1.7E-03	2.9E-03	4.0E-03	1.6E-03	2.7E-03	3.7E-03	8.5E-04	1.5E-03	2.0E-03	8.5E-04	1.5E-03	2.0E-03	3.3E-03	2.5E-03	3.4E-03
C9-C18 Aliphatics	N/A	2.4E-04	2.1E-04	2.2E-06	2.4E-04	2.1E-04	2.2E-06	6.5E-05	5.6E-05	6.0E-07	1.7E-04	1.4E-04	1.3E-06			
C19-C36 Aliphatics	N/A	1.6E-04	1.4E-04	8.9E-06	1.6E-04	1.4E-04	8.9E-06	4.3E-05	3.7E-05	2.3E-06	8.4E-05	7.2E-05	4.6E-06			
C11-C22 Aromatics	N/A	2.7E-03	1.4E-03	1.8E-05	2.7E-03	1.4E-03	1.8E-05	8.9E-04	4.6E-04	5.9E-06	1.6E-03	8.3E-04	1.1E-05			
Total HI: Route and Expos. Pt.		3.0E+00	6.3E+00	1.0E-01	7.5E-01	2.3E+00	5.9E-02	2.1E-01	6.4E-01	1.8E-02	2.3E-01	6.6E-01	1.9E-02	1.0E+00	2.9E+00	5.2E-02
Proportion of complete exposure point			1.0E+00			1.0E+00			1.0E+00			1.0E+00			1.0E+00	
Adjusted Total HI: Route and Expos. Pt.		3.0E+00	6.3E+00	1.0E-01	7.5E-01	2.3E+00	5.9E-02	2.1E-01	6.4E-01	1.8E-02	2.3E-01	6.6E-01	1.9E-02	1.0E+00	2.9E+00	5.2E-02
Total HI: Expos. Pt.			9.4E+00			3.1E+00			8.7E-01			9.1E-01			4.0E+00	

Formula:

$$\text{Cumulative HI} = \sum HI_{\text{Ingestion - chemical specific}} + \sum HI_{\text{Dermal contact - chemical specific}} + \sum HI_{\text{Inhalation - chemical - specific}}$$

HI ingestion-chemical specific = ADD-ingestion-chemical specific x Oral Slope Factor-chemical specific

HI dermal contact-chemical specific = ADD-dermal contact-chemical specific x Oral Slope Factor-chemical specific

HI inhalation-chemical specific = ADE-inhalation-chemical specific x Unit Risk-inhalation-chemical specific

HI = Hazard Index, unitless

ADD = Average Daily Dose, mg/kg/day

ADE = Average Daily Exposure, mg/cu m

Subchronic Oral Reference Dose		X
Chronic Oral Reference Dose		
Subchronic Inhalation Reference Concentration		X
Chronic Inhalation Reference Concentration		

Use capital X to indicate selection

Table 5.1
Calculation of Total Hazard Index (HI): Child Resident, aged 1 Year

Receptor Exposure Point #		Child Resident, aged 1 year						Child Resident, aged 1-8 years							
		1	2	3	4	5	6	7	1	2	3	4	5	6	7
Pathway:															
Soil Exposure Point:															
Incidental ingestion of soil, normal		6.3E+00	2.3E+00	6.4E-01	6.6E-01	2.9E+00									
Inhalation of dusts from disturbed soil		1.0E-01	5.9E-02	1.8E-02	1.9E-02	5.2E-02									
Dermal contact with soil		3.0E+00	7.5E-01	2.1E-01	2.3E-01	1.0E+00									
Total HI		9.4E+00	3.1E+00	8.7E-01	9.1E-01	4.0E+00									
		Subchronic	Subchronic	Subchronic	Subchronic	Subchronic									
MCP Non-Cancer Risk Limit		1.E+00	1.E+00	1.E+00	1.E+00	1.E+00									
Does Total HI exceed MCP Non-Cancer Risk Limit?		Yes	Yes	No	No	Yes									
Significant Risk of Harm?		No	No	No	No	No									

Definition of exposure points															
Exposure Point #		1	2	3	4	5	6	7							
	Soil Exposure Point:														
		Courtyard 0-1 Foot Interval	Courtyard 1-3 Foot Interval	Courtyard 3-6 Foot Interval	Courtyard 3-11 Foot Interval	Stockpiled Fuel Oil Vault Sands SP-3									

NO SINGLE FAMILY RESIDENCE. NO GARDENING OF EDIBLE PRODUCE.
EXPOSURE TO SOILS OCCURS ONLY DURING A SINGLE SIX-MONTH CONSTRUCTION PROJECT, AFTER WHICH TIME
THE SOILS ARE RETURNED TO EXCAVATION OR ARE TRANSPORTED OFF-SITE.
ASSUMES **NO** CONTROLS ARE USED TO LIMIT RESIDENTIAL EXPOSURE TO SOILS DURING CONSTRUCTION PROJECT.
PROTECTIVE COVER MUST REMAIN OVER SOILS EXCEPT DURING CONSTRUCTION OR UTILITY PROJECT, AFTER WHICH TIME THE PROTECTIVE COVER MUST BE RE-INSTALLED.

Table C-1
Comparison of Soil Analytical Data to Published Background Concentrations Identification of Soil Contaminants of Concern
(April 2016)

Parameter	Background	SAMPLING LOCATIONS														
	Soils assoc. with Fill	B-5 (0-1')	B-5 (1-3')	B-5 (0-3')	B-5 (3-6')	B-5 (6-11')	B-7 (0-1')	B-7 (1-3')	B-7 (0-3')	B-7 (3-6')	B-7 (6-11')	B-8 (0-1')	B-8 (1-3')	B-8 (3-6')	B-8 (6-11')	B-9 (0-1')
Sampling Date	Containing	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016
Sample Depth	Coal Ash or Wood Ash	0-1 Feet	1-3 Feet	0-3 Feet	3-6 Feet	6-11 Feet	0-1 Feet	1-3 Feet	0-3 Feet	3-6 Feet	6-11 Feet	0-1 Feet	1-3 Feet	3-6 Feet	6-11 Feet	0-1 Feet
MADEP-EPH-04-1.1 (mg/Kg dry)																
C9-C18 ALIPHATICS				24	26	300			61	ND (11)	ND (22)					
C19-C36 ALIPHATICS				160	64	750			140	28	48					
C11-C22 AROMATICS				310	220	1400			180	83	83					
ACENAPHTHENE	2			1.4	0.76	ND (0.49)			2.6	0.54	ND (0.22)					
ACENAPHTHYLENE	1			0.37	0.11	ND (0.49)			0.38	ND (0.11)	ND (0.22)					
ANTHRACENE	4			3.4	1.8	ND (0.49)			5.4	1.4	0.29					
BENZO(A)ANTHRACENE	9			7.4	4.1	ND (0.49)			11	2.9	1.2					
BENZO(A)PYRENE	7			6.5	3.7	ND (0.49)			9.3	2.4	1.1					
BENZO(B)FLUORANTHENE	8			9.1	5.3	ND (0.49)			12	3.3	1.3					
BENZO(G,H,I)PERYLENE	3			3.4	1.7	ND (0.49)			5.0	1.2	0.66					
BENZO(K)FLUORANTHENE	4			3.0	2.0	ND (0.49)			4.6	1.2	0.52					
CHRYSENE	7			8.5	5.0	ND (0.49)			12	3.2	1.3					
DIBENZ(A,H)ANTHRACENE	1			1.1	0.65	ND (0.49)			1.7	0.41	ND (0.22)					
FLUORANTHENE	10			18	9.5	1.2			26	6.6	2.3					
FLUORENE	2			1.9	0.90	ND (0.49)			3.4	0.78	ND (0.22)					
INDENO(1,2,3-CD)PYRENE	3			4.1	2.1	ND (0.49)			5.1	1.3	0.56					
2-METHYLNAPHTHALENE	1			0.67	0.29	0.70			0.96	0.22	ND (0.22)					
NAPHTHALENE	1			1.7	0.44	0.79			1.5	0.32	ND (0.22)					
PHENANTHRENE	20			15	7.4	1.6			23	6.1	1.2					
PYRENE	20			17	8.8	ND (0.49)			22	5.9	2.4					
BIS(2-ETHYLHEXYL)PHTHALATE (see note 7)																
DIBENZOFURAN (see notes 7, 9)																
DI-N-BUTYLPHTHALATE (see note 7)																
MADEP-VPH-04-1.1 (mg/Kg dry)																
C5-C8 ALIPHATICS																
C9-C12 ALIPHATICS																
C9-C10 AROMATICS																
BENZENE																
ETHYLBENZENE																
METHYL TERT-BUTYL ETHER (MTBE)																
NAPHTHALENE	1															
TOLUENE																
M/P-XYLENE																
O-XYLENE																

Table C-1
Comparison of Soil Analytical Data to Published Background Concentrations Identification of Soil Contaminants of Concern
(April 2016)

Parameter	Background	SAMPLING LOCATIONS														
	Soils assoc. with Fill	B-5 (0-1')	B-5 (1-3')	B-5 (0-3')	B-5 (3-6')	B-5 (6-11')	B-7 (0-1')	B-7 (1-3')	B-7 (0-3')	B-7 (3-6')	B-7 (6-11')	B-8 (0-1')	B-8 (1-3')	B-8 (3-6')	B-8 (6-11')	B-9 (0-1')
SW-846 6010C/D (mg/Kg dry) Metals Digestion																
ANTIMONY	7			ND (2.7)					ND (2.8)							
ARSENIC	20			11					13							
BARIUM	50			120					91							
BERYLLIUM	0.9			1.4					1.3							
CADMIUM	3			0.89					1.2							
CHROMIUM (as +3)	40			34					50							
LEAD	600			100					150							
NICKEL	30			29					26							
SELENIUM	1			ND (5.4)					ND (5.7)							
SILVER	5			ND (0.54)					ND (0.57)							
THALLIUM	5			ND (2.7)					ND (2.8)							
VANADIUM	30			110	55	30			66	31	14			39	41	
ZINC	300			200					260							
SW-846 7471B (mg/Kg dry) Metals Digestion																
MERCURY	1			0.16					0.38							
SW-846 7196A (mg/Kg dry)																
CHROMIUM +6	40															
SW-846 8082A (mg/Kg dry)																
PCB 1016		ND (1.1) *	ND (0.56)		ND (0.57)	ND (0.12)	ND (1.1) *	ND (1.1) *		ND (0.55)	ND (0.11)	ND (6.0) *	ND (0.10)	ND (0.11)	ND (0.11)	ND (5.8) *
PCB 1221		ND (1.1) *	ND (0.56)		ND (0.57)	ND (0.12)	ND (1.1) *	ND (1.1) *		ND (0.55)	ND (0.11)	ND (6.0) *	ND (0.10)	ND (0.11)	ND (0.11)	ND (5.8) *
PCB 1232		ND (1.1) *	ND (0.56)		ND (0.57)	ND (0.12)	ND (1.1) *	ND (1.1) *		ND (0.55)	ND (0.11)	ND (6.0) *	ND (0.10)	ND (0.11)	ND (0.11)	ND (5.8) *
PCB 1242		ND (1.1) *	ND (0.56)		ND (0.57)	ND (0.12)	ND (1.1) *	ND (1.1) *		ND (0.55)	ND (0.11)	ND (6.0) *	ND (0.10)	ND (0.11)	ND (0.11)	ND (5.8) *
PCB 1248		ND (1.1) *	ND (0.56)		ND (0.57)	ND (0.12)	ND (1.1) *	ND (1.1) *		ND (0.55)	ND (0.11)	ND (6.0) *	ND (0.10)	ND (0.11)	ND (0.11)	ND (5.8) *
PCB 1254		7.0	3.7		3.8	0.29	8.5	6.0		2.2	ND (0.11)	39	ND (0.10)	ND (0.11)	ND (0.11)	42
PCB 1260		ND (1.1) *	ND (0.56)		ND (0.57)	ND (0.12)	ND (1.1) *	ND (1.1) *		ND (0.55)	ND (0.11)	ND (6.0) *	ND (0.10)	ND (0.11)	ND (0.11)	ND (5.8) *
PCB 1262		ND (1.1) *	ND (0.56)		ND (0.57)	ND (0.12)	ND (1.1) *	ND (1.1) *		ND (0.55)	ND (0.11)	ND (6.0) *	ND (0.10)	ND (0.11)	ND (0.11)	ND (5.8) *
PCB 1268		ND (1.1) *	ND (0.56)		ND (0.57)	ND (0.12)	ND (1.1) *	ND (1.1) *		ND (0.55)	ND (0.11)	ND (6.0) *	ND (0.10)	ND (0.11)	ND (0.11)	ND (5.8) *
TOTAL PCBs		7.0	3.7		3.8	0.29	8.5	6.0		2.2	ND (0.11)	39	ND (0.10)	ND (0.11)	ND (0.11)	42

Table C-1
Comparison of Soil Analytical Data to Published Background Concentrations Identification of Soil Contaminants of Concern
(April 2016)

Parameter	SAMPLING LOCATION															
	B-9 (1-3')	B-9 (0-3')	B-9 (3-6')	B-9 (6-9')	B-10 (0-1')	B-10 (1-3')	B-10 (0-3')	B-10 (3-6')	B-10 (6-11')	B-11 (0-1')	B-11 (1-3')	B-11 (3-6')	B-11 (6-11')	B-11-r10B (0-1')	B-11-r10B (0-3')	B-11-r10B (1-3')
Sampling Date	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/30/2016	3/30/2016	3/30/2016
Sample Depth	1-3 Feet	0-3 Feet	3-6 Feet	6-9 Feet	0-1 Feet	1-3 Feet	0-3 Feet	3-6 Feet	6-11 Feet	0-1 Feet	1-3 Feet	3-6 Feet	6-11 Feet	0-1 Feet	0-3 Feet	1-3 Feet
MADEP-EPH-04-1.1 (mg/Kg dry)																
C9-C18 ALIPHATICS		ND (12)	ND (11)				18	ND (11)					ND (12)		180	
C19-C36 ALIPHATICS		ND (12)	ND (11)				150	19					46		530	
C11-C22 AROMATICS		37	46				190	31					51		1100	
ACENAPHTHENE		ND (0.12)	ND (0.11)				0.49	ND (0.11)					ND (0.12)		ND (0.23)	
ACENAPHTHYLENE		ND (0.12)	ND (0.11)				ND (0.46)	ND (0.11)					ND (0.12)		ND (0.23)	
ANTHRACENE		0.12	0.38				1.1	ND (0.11)					0.24		0.38	
BENZO(A)ANTHRACENE		0.21	1.2				2.1	0.28					0.54		0.74	
BENZO(A)PYRENE		0.22	1.0				1.4	0.29					0.54		0.68	
BENZO(B)FLUORANTHENE		0.35	1.3				2.4	0.38					0.68		ND (0.23)	
BENZO(G,H,I)PERYLENE		0.13	0.54				1.1	0.18					0.24		0.89	
BENZO(K)FLUORANTHENE		ND (0.12)	0.50				0.67	0.15					0.25		ND (0.23)	
CHRYSENE		0.30	1.3				2.4	0.37					0.61		1.3	
DIBENZ(A,H)ANTHRACENE		ND (0.12)	ND (0.11)				ND (0.46)	ND (0.11)					ND (0.12)		ND (0.23)	
FLUORANTHENE		0.44	2.4				4.1	0.61					1.3		1.7	
FLUORENE		ND (0.12)	ND (0.11)				0.57	ND (0.11)					ND (0.12)		ND (0.23)	
INDENO(1,2,3-CD)PYRENE		0.12	0.59				1.1	0.18					0.32		ND (0.23)	
2-METHYLNAPHTHALENE		ND (0.12)	ND (0.11)				ND (0.46)	ND (0.11)					ND (0.12)		ND (0.23)	
NAPHTHALENE		ND (0.12)	ND (0.11)				ND (0.46)	ND (0.11)					ND (0.12)		ND (0.23)	
PHENANTHRENE		0.51	1.4				4.7	0.55					1.1		1.7	
PYRENE		0.49	2.3				4.1	0.71					1.4		1.2	
BIS(2-ETHYLHEXYL)PHTHALATE (see note 7)																
DIBENZO(FURAN (see notes 7, 9)																
DI-N-BUTYLPHTHALATE (see note 7)																
MADEP-VPH-04-1.1 (mg/Kg dry)																
C5-C8 ALIPHATICS																
C9-C12 ALIPHATICS																
C9-C10 AROMATICS																
BENZENE																
ETHYLBENZENE																
METHYL TERT-BUTYL ETHER (MTBE)																
NAPHTHALENE																
TOLUENE																
M/P-P-XYLENE																
O-XYLENE																

Table C-1
Comparison of Soil Analytical Data to Published Background Concentrations Identification of Soil Contaminants of Concern
(April 2016)

Parameter	SAMPLING LOCATION															
	B-9 (1-3')	B-9 (0-3')	B-9 (3-6')	B-9 (6-9')	B-10 (0-1')	B-10 (1-3')	B-10 (0-3')	B-10 (3-6')	B-10 (6-11')	B-11 (0-1')	B-11 (1-3')	B-11 (3-6')	B-11 (6-11')	B-11-r10B (0-1')	B-11-r10B (0-3')	B-11-r10B (1-3')
SW-846 6010C/D (mg/Kg dry) Metals Digestion																
ANTIMONY			ND (2.7)				ND (2.7)					ND (2.8)				
ARSENIC			11				10					9.2				
BARIUM			30				64					160				
BERYLLIUM			6.7				25					11				
CADMIUM			0.97				0.82					1.3				
CHROMIUM (as +3)			14				26					33				
LEAD			26				68					200				
NICKEL			42				64					85				
SELENIUM			ND (5.4)				ND (5.4)					ND (5.6)				
SILVER			ND (0.54)				ND (0.54)					ND (0.56)				
THALLIUM			ND (2.7)				ND (2.7)					ND (2.8)				
VANADIUM		390	510	120			2100	560	260			900	870		380	
ZINC			81				65					180				
SW-846 7471B (mg/Kg dry) Metals Digestion																
MERCURY			0.19				0.13					1.2				
SW-846 7196A (mg/Kg dry)																
CHROMIUM +6																
SW-846 8082A (mg/Kg dry)																
PCB 1016	ND (0.11)		ND (0.11)	ND (0.11)	ND (2.5) *	ND (0.12)		ND (0.11)	ND (0.11)	ND (13) *	ND (0.11)	ND (0.23)	ND (1.2) *	ND (0.59)		ND (0.11)
PCB 1221	ND (0.11)		ND (0.11)	ND (0.11)	ND (2.5) *	ND (0.12)		ND (0.11)	ND (0.11)	ND (13) *	ND (0.11)	ND (0.23)	ND (1.2) *	ND (0.59)		ND (0.11)
PCB 1232	ND (0.11)		ND (0.11)	ND (0.11)	ND (2.5) *	ND (0.12)		ND (0.11)	ND (0.11)	ND (13) *	ND (0.11)	ND (0.23)	ND (1.2) *	ND (0.59)		ND (0.11)
PCB 1242	ND (0.11)		ND (0.11)	ND (0.11)	ND (2.5) *	ND (0.12)		ND (0.11)	ND (0.11)	ND (13) *	ND (0.11)	ND (0.23)	ND (1.2) *	ND (0.59)		ND (0.11)
PCB 1248	ND (0.11)		ND (0.11)	ND (0.11)	ND (2.5) *	ND (0.12)		ND (0.11)	ND (0.11)	ND (13) *	ND (0.11)	ND (0.23)	ND (1.2) *	ND (0.59)		ND (0.11)
PCB 1254	1.1		ND (0.11)	ND (0.11)	21	0.29		0.79	0.22	100	0.16	2	6.2	6.2		0.48
PCB 1260	ND (0.11)		ND (0.11)	ND (0.11)	ND (2.5) *	ND (0.12)		ND (0.11)	ND (0.11)	ND (13) *	ND (0.11)	ND (0.23)	ND (1.2) *	0.75		ND (0.11)
PCB 1262	ND (0.11)		ND (0.11)	ND (0.11)	ND (2.5) *	ND (0.12)		ND (0.11)	ND (0.11)	ND (13) *	ND (0.11)	ND (0.23)	ND (1.2) *	ND (0.59)		ND (0.11)
PCB 1268	ND (0.11)		ND (0.11)	ND (0.11)	ND (2.5) *	ND (0.12)		ND (0.11)	ND (0.11)	ND (13) *	ND (0.11)	ND (0.23)	ND (1.2) *	ND (0.59)		ND (0.11)
TOTAL PCBs	1.1		ND (0.11)	ND (0.11)	21	0.29		0.79	0.22	100	0.16	2.0	6.2	7.0		0.48

Table C-1
Comparison of Soil Analytical Data to Published Background Concentrations Identification of Soil Contaminants of Concern
(April 2016)

Parameter	SAMPLING LOCATIONS															
	B-11-r5A (0-1')	B-11-r5A (0-3')	B-11-r5A (1-3')	B-11-r5B (0-1')	B-11-r5B (0-3')	B-11-r5B (1-3')	B-11-r5C (0-1')	B-11-r5C (0-3')	B-11-r5C (1-3')	B-12 (0-1')	B-12 (1-3')	B-12 (0-3')	B-12 (3-6')	B-13 (0-1')	B-13 (1-3')	B-13 (0-3')
Sampling Date	3/30/2016	3/30/2016	3/30/2016	3/30/2016	3/30/2016	3/30/2016	3/30/2016	3/30/2016	3/30/2016	3/23/2016	3/23/2016	3/23/2016	3/23/2016	3/23/2016	3/23/2016	3/23/2016
Sample Depth	0-1 Feet	0-3 Feet	1-3 Feet	0-1 Feet	0-3 Feet	1-3 Feet	0-1 Feet	0-3 Feet	1-3 Feet	0-1 Feet	1-3 Feet	0-3 Feet	3-6 Feet	0-1 Feet	1-3 Feet	0-3 Feet
MADEP-EPH-04-1.1 (mg/Kg dry)																
C9-C18 ALIPHATICS		42			24			57				ND (31)	ND (11)			17
C19-C36 ALIPHATICS		230			120			310				65	16			80
C11-C22 AROMATICS		400			97			290				130	34			240
ACENAPHTHENE		0.46			0.58			0.49				1.3	0.39			1.1
ACENAPHTHYLENE		0.77			ND (0.23)			ND (0.24)				ND (0.15)	ND (0.11)			ND (0.14)
ANTHRACENE		4			0.86			0.88				2.3	0.52			0.42
BENZO(A)ANTHRACENE		15			1.4			1.5				2.8	0.70			0.60
BENZO(A)PYRENE		15			1.2			1.6				2.2	0.67			1.0
BENZO(B)FLUORANTHENE		19			1.5			2				3.4	0.85			0.84
BENZO(G,H,I)PERYLENE		8.7			0.58			0.98				0.93	0.36			0.32
BENZO(K)FLUORANTHENE		7			0.53			0.78				1.4	0.33			0.28
CHRYSENE		15			1.6			1.8				2.8	0.68			2.6
DIBENZ(A,H)ANTHRACENE		2.3			ND (0.23)			ND (0.24)				0.41	ND (0.11)			0.35
FLUORANTHENE		31			3.3			5.1				7.8	1.9			1.8
FLUORENE		0.6			0.41			0.42				1.3	0.22			0.17
INDENO(1,2,3-CD)PYRENE		10			0.7			1				1.2	0.41			1.5
2-METHYLNAPHTHALENE		0.31			ND (0.23)			0.28				0.45	ND (0.11)			ND (0.14)
NAPHTHALENE		1.2			ND (0.23)			0.88				0.98	0.16			0.68
PHENANTHRENE		11			4			3.2				8.8	1.8			6.9
PYRENE		31			3.5			3.7				7.1	1.7			6.4
BIS(2-ETHYLHEXYL)PHTHALATE (see note 7)																
DIBENZOFURAN (see notes 7, 9)																
DI-N-BUTYLPHTHALATE (see note 7)																
MADEP-VPH-04-1.1 (mg/Kg dry)																
C5-C8 ALIPHATICS																
C9-C12 ALIPHATICS																
C9-C10 AROMATICS																
BENZENE																
ETHYLBENZENE																
METHYL TERT-BUTYL ETHER (MTBE)																
NAPHTHALENE																
TOLUENE																
M/P-XYLENE																
O-XYLENE																

Table C-1
Comparison of Soil Analytical Data to Published Background Concentrations Identification of Soil Contaminants of Concern
(April 2016)

Parameter	SAMPLING LOCATIONS															
	B-11-r5A (0-1')	B-11-r5A (0-3')	B-11-r5A (1-3')	B-11-r5B (0-1')	B-11-r5B (0-3')	B-11-r5B (1-3')	B-11-r5C (0-1')	B-11-r5C (0-3')	B-11-r5C (1-3')	B-12 (0-1')	B-12 (1-3')	B-12 (0-3')	B-12 (3-6')	B-13 (0-1')	B-13 (1-3')	B-13 (0-3')
SW-846 6010C/D (mg/Kg dry) Metals Digestion																
ANTIMONY																
ARSENIC												4.4	4.1			8.3
BARIUM																
BERYLLIUM																
CADMIUM																
CHROMIUM (as +3)																
LEAD												210	120			1300
NICKEL																
SELENIUM																
SILVER																
THALLIUM																
VANADIUM		140			550			640				20	13			35
ZINC																
SW-846 7471B (mg/Kg dry) Metals Digestion																
MERCURY																
SW-846 7196A (mg/Kg dry)																
CHROMIUM +6																
SW-846 8082A (mg/Kg dry)																
PCB 1016	ND (1.2) *		ND (0.59)	ND (0.59)		ND (0.11)	ND (13) *		ND (0.57)	ND (2.5) *	ND (0.10)		ND (0.11)	ND (3.2) *	ND (6.3) *	
PCB 1221	ND (1.2) *		ND (0.59)	ND (0.59)		ND (0.11)	ND (13) *		ND (0.57)	ND (2.5) *	ND (0.10)		ND (0.11)	ND (3.2) *	ND (6.3) *	
PCB 1232	ND (1.2) *		ND (0.59)	ND (0.59)		ND (0.11)	ND (13) *		ND (0.57)	ND (2.5) *	ND (0.10)		ND (0.11)	ND (3.2) *	ND (6.3) *	
PCB 1242	ND (1.2) *		ND (0.59)	ND (0.59)		ND (0.11)	ND (13) *		ND (0.57)	ND (2.5) *	ND (0.10)		ND (0.11)	ND (3.2) *	ND (6.3) *	
PCB 1248	ND (1.2) *		ND (0.59)	ND (0.59)		ND (0.11)	ND (13) *		ND (0.57)	ND (2.5) *	ND (0.10)		ND (0.11)	ND (3.2) *	ND (6.3) *	
PCB 1254	7.6		5.4	4.0		0.19	97		2.9	11	0.26		0.37	12	25	
PCB 1260	ND (1.2) *		ND (0.59)	ND (0.59)		ND (0.11)	ND (13) *		ND (0.57)	ND (2.5) *	ND (0.10)		ND (0.11)	ND (3.2) *	ND (6.3) *	
PCB 1262	ND (1.2) *		ND (0.59)	ND (0.59)		ND (0.11)	ND (13) *		ND (0.57)	ND (2.5) *	ND (0.10)		ND (0.11)	ND (3.2) *	ND (6.3) *	
PCB 1268	ND (1.2) *		ND (0.59)	ND (0.59)		ND (0.11)	ND (13) *		ND (0.57)	ND (2.5) *	ND (0.10)		ND (0.11)	ND (3.2) *	ND (6.3) *	
TOTAL PCBs	7.6		5.4	4.0		0.19	97		2.9	11	0.26		0.37	12	25	

Table C-1
Comparison of Soil Analytical Data to Published Background Concentrations Identification of Soil Contaminants of Concern
(April 2016)

Parameter	SAMPLING LOCATIONS															
	B-11-r5A (0-1')	B-11-r5A (0-3')	B-11-r5A (1-3')	B-11-r5B (0-1')	B-11-r5B (0-3')	B-11-r5B (1-3')	B-11-r5C (0-1')	B-11-r5C (0-3')	B-11-r5C (1-3')	B-12 (0-1')	B-12 (1-3')	B-12 (0-3')	B-12 (3-6')	B-13 (0-1')	B-13 (1-3')	B-13 (0-3')
SW-846 8081B (mg/Kg dry)																
ALDRIN																
ALPHA-BHC																
BETA-BHC																
DELTA-BHC																
GAMMA-BHC (LINDANE)																
CHLORDANE																
4,4'-DDD																
4,4'-DDE																
4,4'-DDT																
DIELDRIN																
ENDOSULFAN I																
ENDOSULFAN II																
ENDOSULFAN SULFATE																
ENDRIN																
ENDRIN KETONE																
HEPTACHLOR																
HEPTACHLOR EPOXIDE																
HEXACHLORO BENZENE																
METHOXYCHLOR																
SW-846 8151A (mg/kg dry)																
2,4-D																
2,4-DB																
2,4,5-TP (SILVEX)																
2,4,5-T																
DALAPON																
DICAMBA																
DICHLOROPROP																
DINOSEB																
MCPA																
MCPP																
NOTES:																
1. An asterisk (*) following a detection limit indicates that the minimum laboratory reporting limit exceeds one or more of the regul. criteria.																
2. ND = Not detected above the lab reporting limits shown in parenthesis.																
3. NT = Not tested.																
4. ~ = No Method 1 Standard or UCL available																
5. Bolded values exceed the Method 1 Cleanup Standards (exclusive of S-x/GW-1).																
6. Italic values exceed MassDEP published background conc. for soils assoc. with fill containing coal ash or wood ash.																

Table C-1
Comparison of Soil Analytical Data to Published Background Concentrations Identification of Soil Contaminants of Concern
(April 2016)

Parameter	SAMPLING LOCATIONS															
	B-13 (3-6')	BTM-GT-1	BTM-GT-2	ESW-GT-1	NSW-GT-1	NSW-GT-2	SSW-GT-1	SSW-GT-2	WSW-GT-2	SP-1	FO-1 (3')	SP-3	FO-1-TP (0-1')	FO-1-TP (1-2')	FO-1-TP (2-3')	FO-1-BTM
Sampling Date	3/23/2016	3/8/2016	3/8/2016	3/8/2016	3/8/2016	3/8/2016	3/8/2016	3/8/2016	3/8/2016	2/29/2016	3/9/2016	3/29/2016	3/9/2016	3/9/2016	3/9/2016	3/10/2016
Sample Depth	3-6 Feet	6 Feet	8 Feet	3-4 Feet	3-4 Feet	5-6 Feet	3-4 Feet	5-6 Feet	5-6 Feet	Stockpile / Top Soils	3.5 Feet (below vault)	Stockpile / Sands in vault	0-1 Feet (below grade /	1-2 Feet (below grade /	2-3 Feet (below grade /	Bottom of vault (5.5 feet below
MADEP-EPH-04-1.1 (mg/Kg dry)																
C9-C18 ALIPHATICS	ND (12)	ND (12)	ND (11)	13	34	ND (22)	ND (11)	37	ND (11)		ND (10)					
C19-C36 ALIPHATICS	19	ND (12)	31	29	140	77	17	200	ND (11)		ND (10)					
C11-C22 AROMATICS	26	25	45	41	420	120	31	210	33		ND (10)					
ACENAPHTHENE	0.93	ND (0.12)	ND (0.11)	ND (0.11)	1.7	0.37	ND (0.11)	ND (0.43)	ND (0.11)	2.4	ND (0.10)	0.70				
ACENAPHTHYLENE	ND (0.24)	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.23)	ND (0.22)	ND (0.11)	ND (0.43)	ND (0.11)	ND (0.85)	ND (0.10)	ND (0.18)				
ANTHRACENE	1.5	ND (0.12)	ND (0.11)	ND (0.11)	4.7	0.73	ND (0.11)	ND (0.43)	0.18	5.3	ND (0.10)	1.5				
BENZO(A)ANTHRACENE	2.3	ND (0.12)	ND (0.11)	ND (0.11)	10	1.7	ND (0.11)	0.78	0.5	10	ND (0.10)	3.0				
BENZO(A)PYRENE	1.9	0.27	0.11	ND (0.11)	9.3	0.69	0.24	0.94	0.52	8.0	ND (0.10)	2.6				
BENZO(B)FLUORANTHENE	2.5	0.32	0.15	ND (0.11)	13	2	0.31	1.1	0.67	9.8	ND (0.10)	3.5				
BENZO(G,H,I)PERYLENE	0.96	0.38	ND (0.11)	ND (0.11)	4.9	0.96	0.33	0.77	0.41	4.5	ND (0.10)	1.4				
BENZO(K)FLUORANTHENE	0.92	ND (0.12)	ND (0.11)	ND (0.11)	4.8	0.73	ND (0.11)	0.44	0.26	3.9	ND (0.10)	1.4				
CHRYSENE	0.25	0.15	0.11	ND (0.11)	12	1.8	0.17	1.0	0.59	9.7	ND (0.10)	2.8				
DIBENZ(A,H)ANTHRACENE	ND (0.24)	ND (0.12)	ND (0.11)	ND (0.11)	1.5	ND (0.22)	ND (0.11)	ND (0.43)	ND (0.11)	1.4	ND (0.10)	0.59				
FLUORANTHENE	0.56	0.15	0.17	0.14	27	3.7	0.19	1.6	1.1	22	ND (0.10)	7.0				
FLUORENE	0.74	ND (0.12)	ND (0.11)	ND (0.11)	2.1	0.37	ND (0.11)	ND (0.43)	ND (0.11)	2.8	ND (0.10)	0.93				
INDENO(1,2,3-CD)PYRENE	1.2	0.36	ND (0.11)	ND (0.11)	5.2	0.93	0.25	0.56	0.36	5.1	ND (0.10)	1.4				
2-METHYLNAPHTHALENE	ND (0.24)	ND (0.12)	ND (0.11)	ND (0.11)	0.48	ND (0.22)	ND (0.11)	ND (0.43)	ND (0.11)	0.93	ND (0.10)	0.29				
NAPHTHALENE	ND (0.24)	ND (0.12)	ND (0.11)	ND (0.11)	0.70	ND (0.22)	ND (0.11)	ND (0.43)	ND (0.11)	1.6	ND (0.10)	0.59				
PHENANTHRENE	5.9	0.34	ND (0.11)	0.4	19	3	0.24	1.2	0.74	24	ND (0.10)	5.9				
PYRENE	0.51	ND (0.12)	0.18	0.13	25	3.4	0.19	1.6	1	23	ND (0.10)	5.0				
BIS(2-ETHYLHEXYL)PHTHALATE (see note 7)										30		ND (0.36)				
DIBENZOFURAN (see notes 7, 9)										1.9		0.37				
DI-N-BUTYLPHTHALATE (see note 7)										5.6		ND (0.36)				
MADEP-VPH-04-1.1 (mg/Kg dry)																
C5-C8 ALIPHATICS		ND (9.6)	ND (9.9)	ND (9.5)	ND (8.6)	ND (8.3)	ND (10)	ND (11)	ND (8.2)		ND (7.9)	ND (8.9)				ND (8.3)
C9-C12 ALIPHATICS		ND (9.6)	ND (9.9)	ND (9.5)	ND (8.6)	ND (8.3)	ND (10)	ND (11)	ND (8.2)		ND (7.9)	ND (8.9)				ND (8.3)
C9-C10 AROMATICS		ND (9.6)	ND (9.9)	ND (9.5)	ND (8.6)	ND (8.3)	ND (10)	ND (11)	ND (8.2)		ND (7.9)	ND (8.9)				ND (8.3)
BENZENE		0.10	0.058	0.15	ND (0.043)	ND (0.042)	ND (0.052)	ND (0.053)	ND (0.041)		ND (0.040)	ND (0.044)				ND (0.042)
ETHYLBENZENE		ND (0.048)	ND (0.050)	ND (0.047)	ND (0.043)	ND (0.042)	ND (0.052)	ND (0.053)	ND (0.041)		ND (0.040)	ND (0.044)				ND (0.042)
METHYL TERT-BUTYL ETHER (MTBE)		ND (0.048)	ND (0.050)	ND (0.047)	ND (0.043)	ND (0.042)	ND (0.052)	ND (0.053)	ND (0.041)		ND (0.040)	ND (0.044)				ND (0.042)
NAPHTHALENE		ND (0.24)	ND (0.25)	ND (0.24)	ND (0.22)	ND (0.21)	ND (0.26)	ND (0.26)	ND (0.20)		ND (0.20)	ND (0.22)				ND (0.21)
TOLUENE		0.60	0.32	0.23	0.14	ND (0.042)	0.25	0.087	ND (0.041)		ND (0.040)	ND (0.044)				ND (0.042)
M/P-XYLENE		ND (0.096)	ND (0.099)	ND (0.095)	ND (0.086)	ND (0.083)	ND (0.10)	ND (0.11)	ND (0.082)		ND (0.079)	ND (0.089)				ND (0.083)
O-XYLENE		ND (0.048)	ND (0.050)	ND (0.047)	ND (0.043)	ND (0.042)	ND (0.052)	ND (0.053)	ND (0.041)		ND (0.040)	ND (0.044)				ND (0.042)

Table C-1
Comparison of Soil Analytical Data to Published Background Concentrations Identification of Soil Contaminants of Concern
(April 2016)

Parameter	SAMPLING LOCATIONS															
	B-13 (3-6')	BTM-GT-1	BTM-GT-2	ESW-GT-1	NSW-GT-1	NSW-GT-2	SSW-GT-1	SSW-GT-2	WSW-GT-2	SP-1	FO-1 (3')	SP-3	FO-1-TP (0-1')	FO-1-TP (1-2')	FO-1-TP (2-3')	FO-1-BTM
SW-846 6010C/D (mg/Kg dry) Metals Digestion																
ANTIMONY		ND (2.9)	ND (2.7)	ND (2.8)	ND (2.6)	ND (2.8)	ND (2.8)	ND (2.8)	ND (2.7)	ND (3.1)	ND (2.6)	ND (2.4)	3	ND (2.9)	ND (2.9)	ND (2.5)
ARSENIC	5.1	7.4	ND (2.7)	14	9.8	6	3.1	5.7	4.4	23	15	8.8	19	14	18	7
BARIUM		34	27	43	72	42	27	31	28	800	32	50	140	95	130	30
BERYLLIUM		ND (0.29)	ND (0.27)	ND (0.28)	ND (0.26)	ND (0.28)	ND (0.28)	ND (0.28)	ND (0.27)	14	0.63	0.73	0.68	0.39	1.9	ND (0.25)
CADMIUM		0.36	0.34	1.0	0.81	0.61	ND (0.28)	0.60	0.33	3.9	0.51	0.44	1.4	0.98	1.3	0.26
CHROMIUM (as +3)		11	10	14	26	19	12	18	11	160	25	30	36	31	37	20
LEAD	34	100	41	290	230	64	58	59	40	2400	7	25	340	1100	220	6.3
NICKEL		11	8.9	23	22	14	9.0	18	8.8	240	20	18	32	22	29	14
SELENIUM		ND (5.9)	ND (5.4)	ND (5.6)	ND (5.3)	ND (5.6)	ND (5.6)	ND (5.5)	ND (5.5)	ND (6.2)	ND (5.2)	ND (4.8)	ND (5.7)	ND (5.9)	ND (5.7)	ND (5.0)
SILVER		ND (0.59)	ND (0.54)	ND (0.56)	ND (0.53)	ND (0.56)	ND (0.56)	ND (0.55)	ND (0.55)	ND (0.62)	ND (0.52)	ND (0.48)	ND (1.1)	ND (0.59)	ND (0.57)	ND (0.50)
THALLIUM		ND (2.9)	ND (2.7)	ND (2.8)	ND (2.6)	ND (2.8)	ND (2.8)	ND (2.8)	ND (2.7)	ND (3.1)	ND (2.6)	9.8	ND (2.8)	ND (2.9)	ND (2.9)	ND (2.5)
VANADIUM	22	27	14	36	100	32	14	50	15	3500	32	33	160	96	140	29
ZINC		37	43	210	140	89	42	79	35	1100	23	43	250	160	190	29
SW-846 7471B (mg/Kg dry) Metals Digestion																
MERCURY		0.14	0.095	0.63	1.3	0.25	0.10	0.51	0.099	0.43	ND (0.025)	0.050	0.68	0.93	0.84	ND (0.026)
SW-846 7196A (mg/Kg dry)																
CHROMIUM +6										ND (4.9)						
SW-846 8082A (mg/Kg dry)																
PCB 1016	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.11)	ND (1.1) *	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)	ND (12) *	ND (0.10)	ND (0.53)	ND (2.3) *	ND (2.3) *	ND (1.1) *	ND (0.11)
PCB 1221	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.11)	ND (1.1) *	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)	ND (12) *	ND (0.10)	ND (0.53)	ND (2.3) *	ND (2.3) *	ND (1.1) *	ND (0.11)
PCB 1232	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.11)	ND (1.1) *	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)	ND (12) *	ND (0.10)	ND (0.53)	ND (2.3) *	ND (2.3) *	ND (1.1) *	ND (0.11)
PCB 1242	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.11)	ND (1.1) *	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)	ND (12) *	ND (0.10)	ND (0.53)	ND (2.3) *	ND (2.3) *	ND (1.1) *	ND (0.11)
PCB 1248	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.11)	ND (1.1) *	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)	ND (12) *	ND (0.10)	ND (0.53)	ND (2.3) *	ND (2.3) *	ND (1.1) *	ND (0.11)
PCB 1254	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.11)	6.3	1.2	ND (0.11)	0.35	0.16	63	ND (0.10)	2.6	13	12	7.8	ND (0.11)
PCB 1260	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.11)	ND (1.1) *	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)	ND (12) *	ND (0.10)	ND (0.53)	ND (2.3) *	ND (2.3) *	ND (1.1) *	ND (0.11)
PCB 1262	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.11)	ND (1.1) *	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)	ND (12) *	ND (0.10)	ND (0.53)	ND (2.3) *	ND (2.3) *	ND (1.1) *	ND (0.11)
PCB 1268	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.11)	ND (1.1) *	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)	ND (12) *	ND (0.10)	ND (0.53)	ND (2.3) *	ND (2.3) *	ND (1.1) *	ND (0.11)
TOTAL PCBs	ND (0.12)	ND (0.11)	ND (0.11)	ND (0.11)	6.3	1.2	ND (0.11)	0.35	0.16	63	ND (0.10)	2.6	13	12	7.8	ND (0.11)

Table C-1
Comparison of Soil Analytical Data to Published Background Concentrations Identification of Soil Contaminants of Concern
(April 2016)

Parameter	SUMMARY STATISTICS			EVALUATION	
	Number Analyzed	Number Detected	Maximum Concentration Detected	Does Maximum Concentration Exceed Background Concentration for Fill?	Soil Contaminant of Concern
Sampling Date					
Sample Depth					
MADEP-EPH-04-1.1 (mg/Kg dry)					
C9-C18 ALIPHATICS	28	13	300	Not applicable	Yes
C19-C36 ALIPHATICS	28	23	750	Not applicable	Yes
C11-C22 AROMATICS	28	27	1400	Not applicable	Yes
ACENAPHTHENE	30	16	2.6	Yes	Yes
ACENAPHTHYLENE	30	4	0.77	No	Yes - a
ANTHRACENE	30	22	5.4	Yes	Yes
BENZO(A)ANTHRACENE	30	24	15	Yes	Yes
BENZO(A)PYRENE	30	27	15	Yes	Yes
BENZO(B)FLUORANTHENE	30	26	19	Yes	Yes
BENZO(G,H,I)PERYLENE	30	26	8.7	Yes	Yes
BENZO(K)FLUORANTHENE	30	22	7.0	Yes	Yes
CHRYSENE	30	27	15	Yes	Yes
DIBENZ(A,H)ANTHRACENE	30	10	2.3	Yes	Yes
FLUORANTHENE	30	29	31	Yes	Yes
FLUORENE	30	16	3.4	Yes	Yes
INDENO(1,2,3-CD)PYRENE	30	25	10	Yes	Yes
2-METHYLNAPHTHALENE	30	11	0.96	No	Yes - a
NAPHTHALENE	30	13	1.7	Yes	Yes
PHENANTHRENE	30	28	24	Yes	Yes
PYRENE	30	27	31	Yes	Yes
BIS(2-ETHYLHEXYL)PHTHALATE (see note 7)	2	1	30	Not applicable	Yes - f
DIBENZOFURAN (see notes 7, 9)	2	2	1.9	Not applicable	No - b
DI-N-BUTYLPHTHALATE (see note 7)	2	1	5.6	Not applicable	Yes - f
MADEP-VPH-04-1.1 (mg/Kg dry)					
C5-C8 ALIPHATICS	11	0			
C9-C12 ALIPHATICS	11	0			
C9-C10 AROMATICS	11	0			
BENZENE	11	3	0.15	Not applicable	Yes - f
ETHYLBENZENE	11	0			
METHYL TERT-BUTYL ETHER (MTBE)	11	0			
NAPHTHALENE	11	0			
TOLUENE	11	6	0.60	Not applicable	Yes - f
M/P-XYLENE	11	0			
O-XYLENE	11	0			

Table C-1
Comparison of Soil Analytical Data to Published Background Concentrations Identification of Soil Contaminants of Concern
(April 2016)

Parameter	SUMMARY STATISTICS			EVALUATION	
	Number	Number	Maximum Concentration	Does Maximum	Soil
SW-846 6010C/D (mg/Kg dry) Metals Digestion					
ANTIMONY	20	1	3	No	No
ARSENIC	24	23	23	Yes	No - c
BARIUM	20	20	800	Yes	Yes
BERYLLIUM	20	11	25	Yes	Yes
CADMIUM	20	19	3.9	Yes	No - c
CHROMIUM (as +3)	20	20	160	Yes	Yes
LEAD	24	24	2400	Yes	Yes
NICKEL	20	20	240	Yes	Yes
SELENIUM	20	0			
SILVER	20	0			
THALLIUM	20	1	9.8	Yes	Yes - d
VANADIUM	39	39	3500	Yes	Yes
ZINC	20	20	1100	Yes	Yes
SW-846 7471B (mg/Kg dry) Metals Digestion					
MERCURY	20	18	1.3	Yes	No - e
SW-846 7196A (mg/Kg dry)					
CHROMIUM +6	1	0			
SW-846 8082A (mg/Kg dry)					
PCB 1016					
PCB 1221					
PCB 1232					
PCB 1242					
PCB 1248					
PCB 1254					
PCB 1260					
PCB 1262					
PCB 1268					
TOTAL PCBs	53	40	100	Not applicable	Yes

Table C-1
Comparison of Soil Analytical Data to Published Background Concentrations Identification of Soil Contaminants of Concern
(April 2016)

Parameter	SUMMARY STATISTICS			EVALUATION	
	Number	Number	Maximum Concentration	Does Maximum	Soil
SW-846 8081B (mg/Kg dry)					
ALDRIN	20	0			
ALPHA-BHC	20	0			
BETA-BHC	20	0			
DELTA-BHC	20	0			
GAMMA-BHC (LINDANE)	20	0			
CHLORDANE	20	1	0.045	Not applicable	Yes - f
4,4'-DDD	20	0			
4,4'-DDE	20	1	0.093	Not applicable	Yes - g
4,4'-DDT	20	6	0.16	Not applicable	Yes
DIELDRIN	20	4	0.19	Not applicable	Yes
ENDOSULFAN I	20	0			
ENDOSULFAN II	20	0			
ENDOSULFAN SULFATE	20	0			
ENDRIN	20	0			
ENDRIN KETONE	20	0			
HEPTACHLOR	20	0			
HEPTACHLOR EPOXIDE	20	1	0.29	Not applicable	Yes - f, g
HEXACHLOROBENZENE	20	0			
METHOXYCHLOR	20	0			
SW-846 8151A (mg/kg dry)					
2,4-D	8	0			
2,4-DB	8	0			
2,4,5-TP (SILVEX)	8	0			
2,4,5-T	8	0			
DALAPON	8	0			
DICAMBA	8	0			
DICHLOROPROP	8	0			
DINOSEB	8	0			
MCPA	8	0			
MCPP	8	0			
NOTES:					
1. An asterisk (*) following a detection limit indicates that the minimum laboratory reporting limit exceeds one or more of the regul. criteria.	a. This PAH is a contaminant of concern, because most related PAHs are contaminants of concern.				
2. ND = Not detected above the lab reporting limits shown in parenthesis.	b. Dibenzofuran is a component of EPH; therefore, its risk is not evaluated separately.				
3. NT = Not tested.	c. Both arsenic and cadmium were only detected in one soil sample at levels above their published background concentration for soils				
4. ~ = No Method 1 Standard or UCL available	associated with fill containing coal ash or wood ash. This soil sample				
5. Bolded values exceed the Method 1 Cleanup Standards (exclusive of S-x/GW-1).	was collected from stockpile SP-1 (shallow soils scraped from courtyard) and are going to be removed from the property. Therefore, these				
6. Italic values exceed MassDEP published background conc. for soils assoc. with fill containing coal ash or wood ash.	metals are not soil contaminants of concern.				
	d. Thallium was detected at a level above its published background concentration in only one soil sample, collected from the stockpile of				
	soils originating from the fuel oil vault sands. Thallium is a contaminant of concern only for SP-3 (to determine whether these soils can be re-used				
	on-Site.				
	e. Mercury is not a contaminant of concern, because it was detected in				
	only 2 of 20 soil samples, and only slightly above its background				
	concentration.				

Table C-2
Identification of Method to Derive Soil Exposure Point Concentrations and Calculation of Soil Exposure Point Concentrations: 0-1 Foot Interval (PCBs) / 0-3 Foot Interval (Remainder)
(April 2016)

Parameter	MCP - Method 2 Direct Contact Standards			Upper Concentration Limit	SAMPLING LOCATIONS										
	S-1	S-2	S-3		B-5 (0-1')	B-5 (0-3')	B-7 (0-1')	B-7 (0-3')	B-8 (0-1')	B-9 (0-1')	B-9 (0-3')	B-10 (0-1')	B-10 (0-3')	B-11 (0-1')	B-11-r10B (0-1')
Sampling Date					3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/30/2016
Sample Depth					0-1 Feet	0-3 Feet	0-1 Feet	0-3 Feet	0-1 Feet	0-1 Feet	0-3 Feet	0-1 Feet	0-3 Feet	0-1 Feet	0-1 Feet
MADEP-EPH-04.1.1 (mg/Kg dry)															
C9-C18 ALIPHATICS	1000	3000	5000	20000		24		61			6		18		
C19-C36 ALIPHATICS	3000	5000	5000	20000		160		140			6		150		
C11-C22 AROMATICS	1000	3000	5000	10000		310		180			37		190		
ACENAPHTHENE	1000	3000	5000	10000		1.4		2.6			0.06		0.49		
ACENAPHTHYLENE				10000		0.37		0.38			0.06		0.23		
ANTHRACENE	1000	3000	5000	10000		3.4		5.4			0.12		1.1		
BENZO(A)ANTHRACENE	7	40	300	3000		7.4		11			0.21		2.1		
BENZO(A)PYRENE	2	7	30	300		6.5		9.3			0.22		1.4		
BENZO(B)FLUORANTHENE	7	40	300	3000		9.1		12			0.35		2.4		
BENZO(G,H,I)PERYLENE	1000	3000	5000	10000		3.4		5.0			0.13		1.1		
BENZO(K)FLUORANTHENE	70	400	3000	10000		3.0		4.6			0.06		0.67		
CHRYSENE	70	400	3000	10000		8.5		12			0.30		2.4		
DIBENZ(A,H)ANTHRACENE	0.7	4	30	300		1.1		1.7			0.06		0.23		
FLUORANTHENE	1000	3000	5000	10000		18		26			0.44		4.1		
FLUORENE	1000	3000	5000	10000		1.9		3.4			0.06		0.57		
INDENO(1,2,3-CD)PYRENE	7	40	300	3000		4.1		5.1			0.12		1.1		
2-METHYLNAPHTHALENE	300	500	500	5000		0.67		0.96			0.06		0.23		
NAPHTHALENE	500	1000	3000	10000		1.7		1.5			0.06		0.23		
PHENANTHRENE	500	1000	3000	10000		15		23			0.51		4.7		
PYRENE	1000	3000	5000	10000		17		22			0.49		4.1		
SW-846 6010C/D (mg/Kg dry) Metals Digestion															
BARIUM	1000	3000	5000	10000		120		91					64		
BERYLLIUM	90	200	200	2000		1.4		1.3					25		
CHROMIUM (as +3)	1000	3000	5000	10000		34		50					26		
LEAD	200	600	600	6000		100		150					68		
NICKEL	600	1000	1000	10000		29		26					64		
VANADIUM	400	700	700	7000		110		66			390		2100		
ZINC	1000	3000	5000	10000		200		260					65		
SW-846 8082A (mg/Kg dry)															
TOTAL PCBs	1	4	4	100	7.0		8.5		39	42		21		100	7.0
SW-846 8081B (mg/Kg dry)															
4,4'-DDE	6	30	60	600		0.047		0.047					0.046		
4,4'-DDT	6	30	60	600		0.047		0.11					0.046		
DIELDRIN	0.08	0.5	3	30		0.047		0.047					0.046		
NOTES:															
When no analyte detected, one-half reported															
detection limit used to calculate exposure															
point concentration.															

Table C-2
Identification of Method to Derive Soil Exposure Point Concentrations and Calculation of Soil Exposure Point Concentrations: 0-1 Foot Interval (PCBs) / 0-3 Foot Interval (Remainder)
(April 2016)

Parameter	SAMPLING LOCATIONS													
	B-11-r10B (0-3')	B-11-r5A (0-1')	B-11-r5A (0-3')	B-11-r5B (0-1')	B-11-r5B (0-3')	B-11-r5C (0-1')	B-11-r5C (0-3')	B-12 (0-1')	B-12 (0-3')	B-13 (0-1')	B-13 (0-3')	FO-1-TP (0-1') **	FO-1-TP (1-2') **	FO-1-TP (2-3') **
Sampling Date	3/30/2016	3/30/2016	3/30/2016	3/30/2016	3/30/2016	3/30/2016	3/30/2016	3/23/2016	3/23/2016	3/23/2016	3/23/2016	3/9/2016	3/9/2016	3/9/2016
Sample Depth	0-3 Feet	0-1 Feet	0-3 Feet	0-1 Feet	0-3 Feet	0-1 Feet	0-3 Feet	0-1 Feet	0-3 Feet	0-1 Feet	0-3 Feet	0-1 Feet (below grade /	1-2 Feet (below grade /	2-3 Feet (below grade /
MADEP-EPH-04-1.1 (mg/Kg dry)														
C9-C18 ALIPHATICS	180		42		24		57		15.5		17			
C19-C36 ALIPHATICS	530		230		120		310		65		80			
C11-C22 AROMATICS	1100		400		97		290		130		240			
ACENAPHTHENE	0.115		0.46		0.58		0.49		1.3		1.1			
ACENAPHTHYLENE	0.115		0.77		0.115		0.12		0.075		0.07			
ANTHRACENE	0.38		4		0.86		0.88		2.3		0.42			
BENZO(A)ANTHRACENE	0.74		15		1.4		1.5		2.8		0.60			
BENZO(A)PYRENE	0.68		15		1.2		1.6		2.2		1.0			
BENZO(B)FLUORANTHENE	0.115		19		1.5		2		3.4		0.84			
BENZO(G,H,I)PERYLENE	0.89		8.7		0.58		0.98		0.93		0.32			
BENZO(K)FLUORANTHENE	0.115		7		0.53		0.78		1.4		0.28			
CHRYSENE	1.3		15		1.6		1.8		2.8		2.6			
DIBENZ(A,H)ANTHRACENE	0.115		2.3		0.115		0.12		0.41		0.35			
FLUORANTHENE	1.7		31		3.3		5.1		7.8		1.8			
FLUORENE	0.115		0.6		0.41		0.42		1.3		0.17			
INDENO(1,2,3-CD)PYRENE	0.115		10		0.7		1		1.2		1.5			
2-METHYLNAPHTHALENE	0.115		0.31		0.115		0.28		0.45		0.07			
NAPHTHALENE	0.115		1.2		0.115		0.88		0.98		0.68			
PHENANTHRENE	1.7		11		4		3.2		8.8		6.9			
PYRENE	1.2		31		3.5		3.7		7.1		6.4			
SW-846 6010C/D (mg/Kg dry) Metals Digestion														
BARIUM												140	95	130
BERYLLIUM												0.68	0.39	1.9
CHROMIUM (as +3)												36	31	37
LEAD									210		1300	340	1100	220
NICKEL												32	22	29
VANADIUM	380		140		550		640		20		35	160	96	140
ZINC												250	160	190
SW-846 8082A (mg/Kg dry)														
TOTAL PCBs		7.6		4.0		97		11		12		13	12	7.8
SW-846 8081B (mg/Kg dry)														
4,4'-DDE												0.046	0.093	0.045
4,4'-DDT												0.15	0.13	0.13
DIELDRIN												0.16	0.19	0.16
NOTES:														
When no analyte detected, one-half reported												** soils excavated and moved to		
detection limit used to calculate exposure												SP-2. They will be removed from		
point concentration.												the Site.		

Table C-2
Identification of Method to Derive Soil Exposure Point Concentrations and Calculation of Soil Exposure Point Concentrations: 0-1 Foot Interval (PCBs) / 0-3 Foot Interval (Remainder)
(April 2016)

Parameter	Evaluation: S-2 Soils					Derivation of Exposure Point Concentration				
	Number Analyzed	Number Detected > S-2 Standard	% > S-2 Standard	Maximum Concentration	Method to Derive EPC for S-2 Soils	Mean Concentration	Standard Deviation (Population)	95th Percentile Confidence Interval	Upper 95th Percentile Confidence Limit on the Mean	Exposure Point Concentration
Sampling Date										
Sample Depth										
MADEP-EPH-04-1.1 (mg/Kg dry)										
C9-C18 ALIPHATICS	10	0	0	180	Mean	44				44
C19-C36 ALIPHATICS	10	0	0	530	Mean	179				179
C11-C22 AROMATICS	10	0	0	1100	Mean	297				297
ACENAPHTHENE	10	0	0	2.6	Mean	0.86				0.86
ACENAPHTHYLENE	10	0	0	0.77	Mean	0.23				0.23
ANTHRACENE	10	0	0	5.4	Mean	1.9				1.9
BENZO(A)ANTHRACENE	10	0	0	15	Mean	4.3				4.3
BENZO(A)PYRENE	10	2	20.0	15	Mean	3.9				3.9
BENZO(B)FLUORANTHENE	10	0	0	19	Mean	5.1				5.1
BENZO(G,H,I)PERYLENE	10	0	0	8.7	Mean	2.2				2.2
BENZO(K)FLUORANTHENE	10	0	0	7.0	Mean	1.8				1.8
CHRYSENE	10	0	0	15	Mean	4.8				4.8
DIBENZ(A,H)ANTHRACENE	10	0	0	2.3	Mean	0.65				0.65
FLUORANTHENE	10	0	0	31	Mean	9.9				9.9
FLUORENE	10	0	0	3.4	Mean	0.89				0.89
INDENO(1,2,3-CD)PYRENE	10	0	0	10	Mean	2.5				2.5
2-METHYLNAPHTHALENE	10	0	0	0.96	Mean	0.33				0.33
NAPHTHALENE	10	0	0	1.7	Mean	0.75				0.75
PHENANTHRENE	10	0	0	23	Mean	7.9				7.9
PYRENE	10	0	0	31	Mean	9.6				9.6
SW-846 6010C/D (mg/Kg dry) Metals Digestion										
BARIUM	6	0		140	Mean	107				107
BERYLLIUM	6	0		25	Mean	5.1				5.1
CHROMIUM (as +3)	6	0		50	Mean	36				36
LEAD	8	2	25.0	1300	Mean	436				436
NICKEL	6	0		64	Mean	34				34
VANADIUM	13	1	7.7	2100	Mean	371				371
ZINC	6	0		260	Mean	188				188
SW-846 8082A (mg/Kg dry)										
TOTAL PCBs	15	14	93.3	100	95th % UCL	25.92	30.48	15.43	41.35	41
SW-846 8081B (mg/Kg dry)										
4,4'-DDE	6	0		0.093	Mean	0.054				0.054
4,4'-DDT	6	0		0.15	Mean	0.102				0.102
DIELDRIN	6	0		0.19	Mean	0.108				0.108
NOTES:										
When no analyte detected, one-half reported detection limit used to calculate exposure point concentration.										

Table C-3
Identification of Method to Derive Soil Exposure Point Concentrations and Derivation of Soil Exposure Point Concentrations: 1-3 Foot Interval (PCBs) / 0-3 Foot Interval (Remainder)
(April 2016)

Parameter	MCP - Method 2 Direct Contact Standards			Upper Concentration Limit	SAMPLING LOCATIONS										
	S-1	S-2	S-3		B-5 (1-3')	B-5 (0-3')	B-7 (1-3')	B-7 (0-3')	B-8 (1-3')	B-9 (1-3')	B-9 (0-3')	B-10 (1-3')	B-10 (0-3')	B-11 (1-3')	B-11-r10B (0-3')
Sampling Date					3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/30/2016
Sample Depth					1-3 Feet	0-3 Feet	1-3 Feet	0-3 Feet	1-3 Feet	1-3 Feet	0-3 Feet	1-3 Feet	0-3 Feet	1-3 Feet	0-3 Feet
MADEP-EPH-04.1.1 (mg/Kg dry)															
C9-C18 ALIPHATICS	1000	3000	5000	20000		24		61			6.0		18		180
C19-C36 ALIPHATICS	3000	5000	5000	20000		160		140			6.0		150		530
C11-C22 AROMATICS	1000	3000	5000	10000		310		180			37		190		1100
ACENAPHTHENE	1000	3000	5000	10000		1.4		2.6			0.06		0.49		0.115
ACENAPHTHYLENE				10000		0.37		0.38			0.06		0.23		0.115
ANTHRACENE	1000	3000	5000	10000		3.4		5.4			0.12		1.1		0.38
BENZO(A)ANTHRACENE	7	40	300	3000		7.4		11			0.21		2.1		0.74
BENZO(A)PYRENE	2	7	30	300		6.5		9.3			0.22		1.4		0.68
BENZO(B)FLUORANTHENE	7	40	300	3000		9.1		12			0.35		2.4		0.115
BENZO(G,H,I)PERYLENE	1000	3000	5000	10000		3.4		5.0			0.13		1.1		0.89
BENZO(K)FLUORANTHENE	70	400	3000	10000		3.0		4.6			0.06		0.67		0.115
CHRYSENE	70	400	3000	10000		8.5		12			0.30		2.4		1.3
DIBENZ(A,H)ANTHRACENE	0.7	4	30	300		1.1		1.7			0.06		0.23		0.115
FLUORANTHENE	1000	3000	5000	10000		18		26			0.44		4.1		1.7
FLUORENE	1000	3000	5000	10000		1.9		3.4			0.06		0.57		0.115
INDENO(1,2,3-CD)PYRENE	7	40	300	3000		4.1		5.1			0.12		1.1		0.115
2-METHYLNAPHTHALENE	300	500	500	5000		0.67		0.96			0.06		0.23		0.115
NAPHTHALENE	500	1000	3000	10000		1.7		1.5			0.06		0.23		0.115
PHENANTHRENE	500	1000	3000	10000		15		23			0.51		4.7		1.7
PYRENE	1000	3000	5000	10000		17		22			0.49		4.1		1.2
SW-846 6010C/D (mg/Kg dry) Metals Digestion															
BARIUM	1000	3000	5000	10000		120		91					64		
BERYLLIUM	90	200	200	2000		1.4		1.3					25		
CHROMIUM (as +3)	1000	3000	5000	10000		34		50					26		
LEAD	200	600	600	6000		100		150					68		
NICKEL	600	1000	1000	10000		29		26					64		
VANADIUM	400	700	700	7000		110		66			390		2100		380
ZINC	1000	3000	5000	10000		200		260					65		
SW-846 8082A (mg/Kg dry)															
TOTAL PCBs	1	4	4	100	3.7		6.0		0.05	1.1		0.29		0.16	
SW-846 8081B (mg/Kg dry)															
4,4'-DDE	6	30	60	600		0.047		0.047					0.046		
4,4'-DDT	6	30	60	600		0.047		0.11					0.046		
DIELDRIN	0.08	0.5	3	30		0.047		0.047					0.046		
NOTES:															
When no analyte detected, one-half reported															
detection limit used to calculate exposure															
point concentration.															

Table C-3
Identification of Method to Derive Soil Exposure Point Concentrations and Derivation of Soil Exposure Point Concentrations: 1-3 Foot Interval (PCBs) / 0-3 Foot Interval (Remainder)
(April 2016)

Parameter	SAMPLING LOCATIONS										
	B-11-r10B (1-3')	B-11-r5A (0-3')	B-11-r5A (1-3')	B-11-r5B (0-3')	B-11-r5B (1-3')	B-11-r5C (0-3')	B-11-r5C (1-3')	B-12 (1-3')	B-12 (0-3')	B-13 (1-3')	B-13 (0-3')
Sampling Date	3/30/2016	3/30/2016	3/30/2016	3/30/2016	3/30/2016	3/30/2016	3/30/2016	3/23/2016	3/23/2016	3/23/2016	3/23/2016
Sample Depth	1-3 Feet	0-3 Feet	1-3 Feet	0-3 Feet	1-3 Feet	0-3 Feet	1-3 Feet	1-3 Feet	0-3 Feet	1-3 Feet	0-3 Feet
MADEP-EPH-04-1.1 (mg/Kg dry)											
C9-C18 ALIPHATICS		42		24		57			15.5		17
C19-C36 ALIPHATICS		230		120		310			65		80
C11-C22 AROMATICS		400		97		290			130		240
ACENAPHTHENE		0.46		0.58		0.49			1.3		1.1
ACENAPHTHYLENE		0.77		0.115		0.12			0.075		0.07
ANTHRACENE		4.0		0.86		0.88			2.3		0.42
BENZO(A)ANTHRACENE		15		1.4		1.5			2.8		0.60
BENZO(A)PYRENE		15		1.2		1.6			2.2		1.0
BENZO(B)FLUORANTHENE		19		1.5		2.0			3.4		0.84
BENZO(G,H,I)PERYLENE		8.7		0.58		0.98			0.93		0.32
BENZO(K)FLUORANTHENE		7.0		0.53		0.78			1.4		0.28
CHRYSENE		15		1.6		1.8			2.8		2.6
DIBENZ(A,H)ANTHRACENE		2.3		0.115		0.12			0.41		0.35
FLUORANTHENE		31		3.3		5.1			7.8		1.8
FLUORENE		0.60		0.41		0.42			1.3		0.17
INDENO(1,2,3-CD)PYRENE		10		0.70		1.0			1.2		1.5
2-METHYLNAPHTHALENE		0.31		0.115		0.28			0.45		0.07
NAPHTHALENE		1.2		0.115		0.88			0.98		0.68
PHENANTHRENE		11		4.0		3.2			8.8		6.9
PYRENE		31		3.5		3.7			7.1		6.4
SW-846 6010C/D (mg/Kg dry) Metals Digestion											
BARIUM											
BERYLLIUM											
CHROMIUM (as +3)											
LEAD									210		1300
NICKEL											
VANADIUM		140		550		640			20		35
ZINC											
SW-846 8082A (mg/Kg dry)											
TOTAL PCBs	0.48		5.4		0.19		2.9	0.26		25	
SW-846 8081B (mg/Kg dry)											
4,4'-DDE											
4,4'-DDT											
DIELDRIN											
NOTES:											
When no analyte detected, one-half reported											
detection limit used to calculate exposure											
point concentration.											

Table C-3
Identification of Method to Derive Soil Exposure Point Concentrations and Derivation of Soil Exposure Point Concentrations: 1-3 Foot Interval (PCBs) / 0-3 Foot Interval (Remainder)
(April 2016)

Parameter	Evaluation: S-2 Soils					Derivation of Exposure Point Concentration				
	Number Analyzed	Number Detected > S-2 Standard	% > S-2 Standard	Maximum Concentration	Method to Derive EPC for S-2 Soils	Mean Concentration	Standard Deviation (Population)	95th Percentile Confidence Interval	Upper 95th Percentile Confidence Limit on the Mean	Exposure Point Concentration
Sampling Date										
Sample Depth										
MADEP-EPH-04-1.1 (mg/Kg dry)										
C9-C18 ALIPHATICS	10	0	0	180	Mean	44				44
C19-C36 ALIPHATICS	10	0	0	530	Mean	179				179
C11-C22 AROMATICS	10	0	0	1100	Mean	297				297
ACENAPHTHENE	10	0	0	2.6	Mean	0.9				0.86
ACENAPHTHYLENE	10	0	0	0.77	Mean	0.23				0.23
ANTHRACENE	10	0	0	5.4	Mean	1.9				1.9
BENZO(A)ANTHRACENE	10	0	0	15	Mean	4.3				4.3
BENZO(A)PYRENE	10	2	20.0	15	Mean	3.9				3.9
BENZO(B)FLUORANTHENE	10	0	0	19	Mean	5.1				5.1
BENZO(G,H,I)PERYLENE	10	0	0	8.7	Mean	2.2				2.2
BENZO(K)FLUORANTHENE	10	0	0	7.0	Mean	1.8				1.8
CHRYSENE	10	0	0	15	Mean	4.8				4.8
DIBENZ(A,H)ANTHRACENE	10	0	0	2.3	Mean	0.65				0.65
FLUORANTHENE	10	0	0	31	Mean	9.9				9.9
FLUORENE	10	0	0	3.4	Mean	0.89				0.89
INDENO(1,2,3-CD)PYRENE	10	0	0	10	Mean	2.5				2.5
2-METHYLNAPHTHALENE	10	0	0	0.96	Mean	0.33				0.33
NAPHTHALENE	10	0	0	1.7	Mean	0.75				0.75
PHENANTHRENE	10	0	0	23	Mean	7.9				7.9
PYRENE	10	0	0	31	Mean	9.6				9.6
SW-846 6010C/D (mg/Kg dry) Metals Digestion										
BARIUM	3	0		120	Mean	92				92
BERYLLIUM	3	0		25	Mean	9.2				9.2
CHROMIUM (as +3)	3	0		50	Mean	37				37
LEAD	5	1	20.0	1300	Mean	366				366
NICKEL	3	0		64	Mean	40				40
VANADIUM	10	1	10.0	2100	Mean	443				443
ZINC	3	0		260	Mean	175				175
SW-846 8082A (mg/Kg dry)										
TOTAL PCBs	12	3	25	25	95th % UCL	3.8	6.72	3.80	7.59	7.6
SW-846 8081B (mg/Kg dry)										
4,4'-DDE	3	0		0.047	Mean	0.047				0.047
4,4'-DDT	3	0		0.11	Mean	0.068				0.068
DIELDRIN	3	0		0.047	Mean	0.047				0.047
NOTES:										
When no analyte detected, one-half reported detection limit used to calculate exposure point concentration.										

Table C-4
Identification of Method to Derive Soil Exposure Point Concentrations and Derivation of Soil Exposure Point Concentrations: 3-6 Foot Interval (PCBs and Remainder)
(April 2016)

Parameter	MCP - Method 2 Direct Contact Standards			Upper Concentration Limit	SAMPLING LOCATIONS											
	S-1	S-2	S-3	UCL	B-5 (3-6')	B-7 (3-6')	B-8 (3-6')	B-9 (3-6')	B-10 (3-6')	B-11 (3-6')	B-12 (3-6')	B-13 (3-6')	BTM-GT-1	BTM-GT-2	ESW-GT-1	NSW-GT-1
Sampling Date					3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/23/2016	3/23/2016	3/8/2016	3/8/2016	3/8/2016	3/8/2016
Sample Depth					3-6 Feet	3-6 Feet	3-6 Feet	3-6 Feet	3-6 Feet	3-6 Feet	3-6 Feet	3-6 Feet	6 Feet	8 Feet	3-4 Feet	3-4 Feet
MADEP-EPH-04-1.1 (mg/Kg dry)																
C9-C18 ALIPHATICS	1000	3000	5000	20000	26	5.5		5.5	5.5		5.5	6.0	6.0	5.5	13	34
C19-C36 ALIPHATICS	3000	5000	5000	20000	64	28		5.5	19		16	19	6.0	31	29	140
C11-C22 AROMATICS	1000	3000	5000	10000	220	83		46	31		34	26	25	45	41	420
ACENAPHTHENE	1000	3000	5000	10000	0.76	0.54		0.055	0.055		0.39	0.93	0.060	0.055	0.055	1.7
ACENAPHTHYLENE				10000	0.11	0.055		0.055	0.055		0.055	0.12	0.060	0.055	0.055	0.115
ANTHRACENE	1000	3000	5000	10000	1.8	1.4		0.38	0.055		0.52	1.5	0.060	0.055	0.055	4.7
BENZO(A)ANTHRACENE	7	40	300	3000	4.1	2.9		1.2	0.28		0.70	2.3	0.060	0.055	0.055	10
BENZO(A)PYRENE	2	7	30	300	3.7	2.4		1.0	0.29		0.67	1.9	0.27	0.11	0.055	9.3
BENZO(B)FLUORANTHENE	7	40	300	3000	5.3	3.3		1.3	0.38		0.85	2.5	0.32	0.15	0.055	13
BENZO(G,H,I)PERYLENE	1000	3000	5000	10000	1.7	1.2		0.54	0.18		0.36	0.96	0.38	0.055	0.055	4.9
BENZO(K)FLUORANTHENE	70	400	3000	10000	2.0	1.2		0.50	0.15		0.33	0.92	0.060	0.055	0.055	4.8
CHRYSENE	70	400	3000	10000	5.0	3.2		1.3	0.37		0.68	0.25	0.15	0.11	0.055	12
DIBENZ(A,H)ANTHRACENE	0.7	4	30	300	0.65	0.41		0.055	0.055		0.055	0.12	0.060	0.055	0.055	1.5
FLUORANTHENE	1000	3000	5000	10000	9.5	6.6		2.4	0.61		1.9	0.56	0.15	0.17	0.14	27
FLUORENE	1000	3000	5000	10000	0.90	0.78		0.055	0.055		0.22	0.74	0.060	0.055	0.055	2.1
INDENO(1,2,3-CD)PYRENE	7	40	300	3000	2.1	1.3		0.59	0.18		0.41	1.2	0.36	0.055	0.055	5.2
2-METHYLNAPHTHALENE	300	500	500	5000	0.29	0.22		0.055	0.055		0.055	0.12	0.060	0.055	0.055	0.48
NAPHTHALENE	500	1000	3000	10000	0.44	0.32		0.055	0.055		0.16	0.12	0.060	0.055	0.055	0.70
PHENANTHRENE	500	1000	3000	10000	7.4	6.1		1.4	0.55		1.8	5.9	0.34	0.055	0.4	19
PYRENE	1000	3000	5000	10000	8.8	5.9		2.3	0.71		1.7	0.51	0.060	0.18	0.13	25
MADEP-VPH-04-1.1 (mg/Kg dry)																
BENZENE	2	40	40	10000									0.10	0.058	0.15	0.0215
TOLUENE	30	500	500	10000									0.60	0.32	0.23	0.14
SW-846 6010C/D (mg/Kg dry) Metals Digestion																
BARIUM	1000	3000	5000	10000				30		160			34	27	43	72
BERYLLIUM	90	200	200	2000				6.7		11			0.145	0.135	0.14	0.13
CHROMIUM (as +3)	1000	3000	5000	10000				14		33			11	10	14	26
LEAD	200	600	600	6000				26		200	120	34	100	41	290	230
NICKEL	600	1000	1000	10000				42		85			11	8.9	23	22
VANADIUM	400	700	700	7000	55	31	39	510	560	900	13	22	27	14	36	100
ZINC	1000	3000	5000	10000				81		180			37	43	210	140
SW-846 8082A (mg/Kg dry)																
TOTAL PCBs	1	4	4	100	3.8	2.2	0.055	0.055	0.79	2.0	0.37	0.060	0.055	0.055	0.055	6.3
SW-846 8081B (mg/Kg dry)																
CHLORDANE	5	5	5	600				0.23		0.235			0.0115	0.11	0.011	0.225
4,4'-DDT	6	30	60	600				0.0455		0.16			0.0023	0.022	0.00225	0.045
DIELDRIN	0.08	0.5	3	30				0.0455		0.047			0.0023	0.022	0.00225	0.11
NOTES:																
When no analyte detected, one-half reported detection limit used to calculate exposure point concentration.																

Table C-4
Identification of Method to Derive Soil Exposure Point Concentrations and Derivation of Soil Exposure Point Concentrations: 3-6 Foot Interval (PCBs and Remainder)
(April 2016)

Parameter	SAMPLING LOCATIONS				Evaluation: S-2 Soils					Derivation of Exposure Point Concentration				
	NSW-GT-2	SSW-GT-1	SSW-GT-2	WSW-GT-2	Number Analyzed	Number Detected > S-2 Standard	% > S-2 Standard	Maximum Concentration	Method to Derive EPC for S-2 Soils	Mean Concentration	Standard Deviation (Population)	95th Percentile Confidence Interval	Upper 95th Percentile Confidence Limit on the Mean	Exposure Point Concentration
Sampling Date	3/8/2016	3/8/2016	3/8/2016	3/8/2016										
Sample Depth	5-6 Feet	3-4 Feet	5-6 Feet	5-6 Feet										
MADEP-EPH-04-1.1 (mg/Kg dry)														
C9-C18 ALIPHATICS	11	5.5	37	5.5	14	0		37	Mean	12				12
C19-C36 ALIPHATICS	77	17	200	5.5	14	0		200	Mean	47				47
C11-C22 AROMATICS	120	31	210	33	14	0		420	Mean	98				98
ACENAPHTHENE	0.37	0.055	0.215	0.055	14	0		1.7	Mean	0.38				0.38
ACENAPHTHYLENE	0.11	0.055	0.215	0.055	14	0		0.215	Mean	0.084				0.084
ANTHRACENE	0.73	0.055	0.215	0.18	14	0		4.7	Mean	0.84				0.84
BENZO(A)ANTHRACENE	1.7	0.055	0.78	0.5	14	0		10	Mean	1.8				1.8
BENZO(A)PYRENE	0.69	0.24	0.94	0.52	14	1	7.1	9.3	Mean	1.6				1.6
BENZO(B)FLUORANTHENE	2	0.31	1.1	0.67	14	0		13	Mean	2.2				2.2
BENZO(G,H,I)PERYLENE	0.96	0.33	0.77	0.41	14	0		4.9	Mean	0.91				0.91
BENZO(K)FLUORANTHENE	0.73	0.055	0.44	0.26	14	0		4.8	Mean	0.83				0.83
CHRYSENE	1.8	0.17	1.0	0.59	14	0		12	Mean	1.9				1.9
DIBENZ(A,H)ANTHRACENE	0.11	0.055	0.215	0.055	14	0		1.5	Mean	0.25				0.25
FLUORANTHENE	3.7	0.19	1.6	1.1	14	0		27	Mean	4.0				4.0
FLUORENE	0.37	0.055	0.215	0.055	14	0		2.1	Mean	0.41				0.41
INDENO(1,2,3-CD)PYRENE	0.93	0.25	0.56	0.36	14	0		5.2	Mean	0.97				0.97
2-METHYLNAPHTHALENE	0.11	0.055	0.215	0.055	14	0		0.48	Mean	0.13				0.13
NAPHTHALENE	0.11	0.055	0.215	0.055	14	0		0.70	Mean	0.18				0.18
PHENANTHRENE	3.0	0.24	1.2	0.74	14	0		19	Mean	3.4				3.4
PYRENE	3.4	0.19	1.6	1.0	14	0		25	Mean	3.7				3.7
MADEP-VPH-04-1.1 (mg/Kg dry)														
BENZENE	0.021	0.026	0.0265	0.0205	8	0		0.15	Mean	0.053				0.053
TOLUENE	0.021	0.25	0.087	0.0205	8	0		0.60	Mean	0.21				0.21
SW-846 6010C/D (mg/Kg dry) Metals Digestion														
BARIUM	42	27	31	28	10	0		160	Mean	49				49
BERYLLIUM	0.14	0.14	0.14	0.135	10	0		11	Mean	1.9				1.9
CHROMIUM (as +3)	19	12	18	11	10	0		33	Mean	17				17
LEAD	64	58	59	40	12	0		290	Mean	105				105
NICKEL	14	9.0	18	8.8	10	0		85	Mean	24				24
VANADIUM	32	14	50	15	16	1	6.3	900	Mean	151				151
ZINC	89	42	79	35	10	0		210	Mean	94				94
SW-846 8082A (mg/Kg dry)														
TOTAL PCBs	1.2	0.055	0.35	0.16	16	1	6.3	6.3	95th % UCL	1.1	1.70	0.83	1.93	1.9
SW-846 8081B (mg/Kg dry)														
CHLORDANE	0.22	0.011	0.215	0.045	10	0		0.235	Mean	0.13				0.13
4,4'-DDT	0.044	0.00225	0.0435	0.0022	10	0		0.16	Mean	0.037				0.037
DIELDRIN	0.044	0.00225	0.0435	0.0022	10	0		0.11	Mean	0.032				0.032
NOTES:														
When no analyte detected, one-half reported detection limit used to calculate exposure point concentration.														

Table C-5
Identification of Method to Derive Soil Exposure Point Concentrations and Derivation of Soil Exposure Point Concentrations: 3-11 Foot Interval (PCBs and Remainder)
(April 2016)

Parameter	MCP - Method 2 Direct Contact Standards			Upper Concentration Limit	SAMPLING LOCATION											
	S-1	S-2	S-3	UCL	B-5 (3-6')	B-5 (6-11')	B-7 (3-6')	B-7 (6-11')	B-8 (3-6')	B-8 (6-11')	B-9 (3-6')	B-9 (6-9')	B-10 (3-6')	B-10 (6-11')	B-11 (3-6')	B-11 (6-11')
Sampling Date					3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016	3/14/2016
Sample Depth					3-6 Feet	6-11 Feet	3-6 Feet	6-11 Feet	3-6 Feet	6-11 Feet	3-6 Feet	6-9 Feet	3-6 Feet	6-11 Feet	3-6 Feet	6-11 Feet
MADEP-EPH-04-1.1 (mg/Kg dry)																
C9-C18 ALIPHATICS	1000	3000	5000	20000	26	300	5.5	11			11		11			6.0
C19-C36 ALIPHATICS	3000	5000	5000	20000	64	750	28	48			11		19			46
C11-C22 AROMATICS	1000	3000	5000	10000	220	1400	83	83			46		31			51
ACENAPHTHENE	1000	3000	5000	10000	0.76	0.245	0.54	0.11			0.055		0.055			0.06
ACENAPHTHYLENE				10000	0.11	0.245	0.055	0.11			0.055		0.055			0.06
ANTHRACENE	1000	3000	5000	10000	1.8	0.245	1.4	0.29			0.38		0.055			0.24
BENZO(A)ANTHRACENE	7	40	300	3000	4.1	0.245	2.9	1.2			1.2		0.28			0.54
BENZO(A)PYRENE	2	7	30	300	3.7	0.245	2.4	1.1			1.0		0.29			0.54
BENZO(B)FLUORANTHENE	7	40	300	3000	5.3	0.245	3.3	1.3			1.3		0.38			0.68
BENZO(G,H,I)PERYLENE	1000	3000	5000	10000	1.7	0.245	1.2	0.66			0.54		0.18			0.24
BENZO(K)FLUORANTHENE	70	400	3000	10000	2.0	0.245	1.2	0.52			0.50		0.15			0.25
CHRYSENE	70	400	3000	10000	5.0	0.245	3.2	1.3			1.3		0.37			0.61
DIBENZ(A,H)ANTHRACENE	0.7	4	30	300	0.65	0.245	0.41	0.11			0.055		0.055			0.06
FLUORANTHENE	1000	3000	5000	10000	9.5	1.2	6.6	2.3			2.4		0.61			1.3
FLUORENE	1000	3000	5000	10000	0.90	0.245	0.78	0.11			0.055		0.055			0.06
INDENO(1,2,3-CD)PYRENE	7	40	300	3000	2.1	0.245	1.3	0.56			0.59		0.18			0.32
2-METHYLNAPHTHALENE	300	500	500	5000	0.29	0.70	0.22	0.11			0.055		0.055			0.06
NAPHTHALENE	500	1000	3000	10000	0.44	0.79	0.32	0.11			0.055		0.055			0.06
PHENANTHRENE	500	1000	3000	10000	7.4	1.6	6.1	1.2			1.4		0.55			1.1
PYRENE	1000	3000	5000	10000	8.8	0.245	5.9	2.4			2.3		0.71			1.4
MADEP-VPH-04-1.1 (mg/Kg dry)																
BENZENE	2	40	40	10000												
TOLUENE	30	500	500	10000												
SW-846 6010C/D (mg/Kg dry) Metals Digestion																
BARIUM	1000	3000	5000	10000							30				160	
BERYLLIUM	90	200	200	2000							6.7				11	
CHROMIUM (as +3)	1000	3000	5000	10000							14				33	
LEAD	200	600	600	6000							26				200	
NICKEL	600	1000	1000	10000							42				85	
VANADIUM	400	700	700	7000	55	30	31	14	39	41	510	120	560	260	900	870
ZINC	1000	3000	5000	10000							81				180	
SW-846 8082A (mg/Kg dry)																
TOTAL PCBs	1	4	4	100	3.8	0.29	2.2	0.055	0.055	0.055	0.055	0.055	0.79	0.22	2.0	6.2
SW-846 8081B (mg/Kg dry)																
CHLORDANE	5	5	5	600							0.23				0.235	
4,4'-DDT	6	30	60	600							0.0455				0.16	
DIELDRIN	0.08	0.5	3	30							0.0455				0.047	
NOTES:																
When no analyte detected, one-half reported detection limit used to calculate exposure point concentration.																

Table C-5
Identification of Method to Derive Soil Exposure Point Concentrations and Derivation of Soil Exposure Point Concentrations: 3-11 Foot Interval (PCBs and Remainder)
(April 2016)

Parameter	SAMPLING LOCATIONS								
	B-13 (3-6')	BTM-GT-1	BTM-GT-2	ESW-GT-1	NSW-GT-1	NSW-GT-2	SSW-GT-1	SSW-GT-2	WSW-GT-2
Sampling Date	3/23/2016	3/8/2016	3/8/2016	3/8/2016	3/8/2016	3/8/2016	3/8/2016	3/8/2016	3/8/2016
Sample Depth	3-6 Feet	6 Feet	8 Feet	3-4 Feet	3-4 Feet	5-6 Feet	3-4 Feet	5-6 Feet	5-6 Feet
MADEP-EPH-04-1.1 (mg/Kg dry)									
C9-C18 ALIPHATICS	6.0	6.0	5.5	13	34	11	5.5	37	5.5
C19-C36 ALIPHATICS	19	6.0	31	29	140	77	17	200	5.5
C11-C22 AROMATICS	26	25	45	41	420	120	31	210	33
ACENAPHTHENE	0.93	0.060	0.055	0.055	1.7	0.37	0.055	0.215	0.055
ACENAPHTHYLENE	0.12	0.060	0.055	0.055	0.115	0.11	0.055	0.215	0.055
ANTHRACENE	1.5	0.060	0.055	0.055	4.7	0.73	0.055	0.215	0.18
BENZO(A)ANTHRACENE	2.3	0.060	0.055	0.055	10	1.7	0.055	0.78	0.5
BENZO(A)PYRENE	1.9	0.27	0.11	0.055	9.3	0.69	0.24	0.94	0.52
BENZO(B)FLUORANTHENE	2.5	0.32	0.15	0.055	13	2	0.31	1.1	0.67
BENZO(G,H,I)PERYLENE	0.96	0.38	0.055	0.055	4.9	0.96	0.33	0.77	0.41
BENZO(K)FLUORANTHENE	0.92	0.060	0.055	0.055	4.8	0.73	0.055	0.44	0.26
CHRYSENE	0.25	0.15	0.11	0.055	12	1.8	0.17	1.0	0.59
DIBENZ(A,H)ANTHRACENE	0.12	0.060	0.055	0.055	1.5	0.11	0.055	0.215	0.055
FLUORANTHENE	0.56	0.15	0.17	0.14	27	3.7	0.19	1.6	1.1
FLUORENE	0.74	0.060	0.055	0.055	2.1	0.37	0.055	0.215	0.055
INDENO(1,2,3-CD)PYRENE	1.2	0.36	0.055	0.055	5.2	0.93	0.25	0.56	0.36
2-METHYLNAPHTHALENE	0.12	0.060	0.055	0.055	0.48	0.11	0.055	0.215	0.055
NAPHTHALENE	0.12	0.060	0.055	0.055	0.70	0.11	0.055	0.215	0.055
PHENANTHRENE	5.9	0.34	0.055	0.4	19	3.0	0.24	1.2	0.74
PYRENE	0.51	0.060	0.18	0.13	25	3.4	0.19	1.6	1.0
MADEP-VPH-04-1.1 (mg/Kg dry)									
BENZENE		0.10	0.058	0.15	0.0215	0.021	0.026	0.0265	0.0205
TOLUENE		0.60	0.32	0.23	0.14	0.021	0.25	0.087	0.0205
SW-846 6010C/D (mg/Kg dry) Metals Digestion									
BARIUM		34	27	43	72	42	27	31	28
BERYLLIUM		0.145	0.135	0.14	0.13	0.14	0.14	0.14	0.135
CHROMIUM (as +3)		11	10	14	26	19	12	18	11
LEAD	34	100	41	290	230	64	58	59	40
NICKEL		11	8.9	23	22	14	9.0	18	8.8
VANADIUM	22	27	14	36	100	32	14	50	15
ZINC		37	43	210	140	89	42	79	35
SW-846 8082A (mg/Kg dry)									
TOTAL PCBs	0.060	0.055	0.055	0.055	6.3	1.2	0.055	0.35	0.16
SW-846 8081B (mg/Kg dry)									
CHLORDANE		0.0115	0.11	0.011	0.225	0.22	0.011	0.215	0.045
4,4'-DDT		0.0023	0.022	0.00225	0.045	0.044	0.00225	0.0435	0.0022
DIELDRIN		0.0023	0.022	0.00225	0.11	0.044	0.00225	0.0435	0.0022
NOTES:									
When no analyte detected, one-half reported									
detection limit used to calculate exposure									
point concentration.									

Table C-5
Identification of Method to Derive Soil Exposure Point Concentrations and Derivation of Soil Exposure Point Concentrations: 3-11 Foot Interval (PCBs and Remainder)
(April 2016)

Parameter	Evaluation: S-2 Soils					Derivation of Exposure Point Concentration				
	Number Analyzed	Number Detected	% > S-2 Standard	Maximum Concentration	Method to Derive	Mean Concentration	Standard Deviation (Population)	95th Percentile Confidence Interval	Upper 95th Percentile Confidence Limit on the Mean	Exposure Point Concentration
Sampling Date					Derive					
Sample Depth		> S-2 Standard			EPC for S-2 Soils					
MADEP-EPH-04-1.1 (mg/Kg dry)										
C9-C18 ALIPHATICS	16	0		300	Mean	31				31
C19-C36 ALIPHATICS	16	0		750	Mean	93				93
C11-C22 AROMATICS	16	0		1400	Mean	179				179
ACENAPHTHENE	16	0		1.7	Mean	0.33				0.33
ACENAPHTHYLENE	16	0		0.245	Mean	0.096				0.096
ANTHRACENE	16	0		4.7	Mean	0.75				0.75
BENZO(A)ANTHRACENE	16	0		10	Mean	1.6				1.6
BENZO(A)PYRENE	16	1	6.3	9.3	Mean	1.5				1.5
BENZO(B)FLUORANTHENE	16	0		13	Mean	2.0				2.0
BENZO(G,H,I)PERYLENE	16	0		4.9	Mean	0.85				0.85
BENZO(K)FLUORANTHENE	16	0		4.8	Mean	0.77				0.77
CHRYSENE	16	0		12	Mean	1.8				1.8
DIBENZ(A,H)ANTHRACENE	16	0		1.5	Mean	0.24				0.24
FLUORANTHENE	16	0		27	Mean	3.7				3.7
FLUORENE	16	0		2.1	Mean	0.37				0.37
INDENO(1,2,3-CD)PYRENE	16	0		5.2	Mean	0.89				0.89
2-METHYLNAPHTHALENE	16	0		0.7	Mean	0.17				0.17
NAPHTHALENE	16	0		0.79	Mean	0.20				0.20
PHENANTHRENE	16	0		19	Mean	3.1				3.1
PYRENE	16	0		25	Mean	3.4				3.4
MADEP-VPH-04-1.1 (mg/Kg dry)										
BENZENE	8	0		0.15	Mean	0.053				0.053
TOLUENE	8	0		0.6	Mean	0.21				0.21
SW-846 6010C/D (mg/Kg dry) Metals Digestion										
BARIUM	10	0		160	Mean	49				49
BERYLLIUM	10	0		11	Mean	1.9				1.9
CHROMIUM (as +3)	10	0		33	Mean	17				17
LEAD	11	0		290	Mean	104				104
NICKEL	10	0		85	Mean	24				24
VANADIUM	21	1	4.8	900	Mean	178				178
ZINC	10	0		210	Mean	94				94
SW-846 8082A (mg/Kg dry)										
TOTAL PCBs	21	2	9.5	6.3	95th % UCL	1.1	1.90	0.81	1.96	2.0
SW-846 8081B (mg/Kg dry)										
CHLORDANE	10	0		0.235	Mean	0.13				0.13
4,4'-DDT	10	0		0.16	Mean	0.037				0.037
DIELDRIN	10	0		0.11	Mean	0.032				0.032
NOTES:										
When no analyte detected, one-half reported detection limit used to calculate exposure point concentration.										

Table C-6
Identification of Method to Derive Soil Exposure Point Concentrations and Derivation of Soil Exposure Point Concentrations: Fuel Oil Vault Sands (SP-3)
(April 2016)

Parameter	MCP - Method 2 Direct Contact Standards			Upper Concentration Limit				
	S-1	S-2	S-3	UCL	SP-3	FO-1-TP (0-1')	FO-1-TP (1-2')	FO-1-TP (2-3')
Sampling Date					3/29/2016	3/9/2016	3/9/2016	3/9/2016
Sample Depth					Stockpile / Sands in vault	0-1 Feet (below grade /	1-2 Feet (below grade /	2-3 Feet (below grade /
MADEP-EPH-04-1.1 (mg/Kg dry)								
ACENAPHTHENE	1000	3000	5000	10000	0.70			
ACENAPHTHYLENE				10000	0.090			
ANTHRACENE	1000	3000	5000	10000	1.5			
BENZO(A)ANTHRACENE	7	40	300	3000	3.0			
BENZO(A)PYRENE	2	7	30	300	2.6			
BENZO(B)FLUORANTHENE	7	40	300	3000	3.5			
BENZO(G,H,I)PERYLENE	1000	3000	5000	10000	1.4			
BENZO(K)FLUORANTHENE	70	400	3000	10000	1.4			
CHRYSENE	70	400	3000	10000	2.8			
DIBENZ(A,H)ANTHRACENE	0.7	4	30	300	0.59			
FLUORANTHENE	1000	3000	5000	10000	7.0			
FLUORENE	1000	3000	5000	10000	0.93			
INDENO(1,2,3-CD)PYRENE	7	40	300	3000	1.4			
2-METHYLNAPHTHALENE	300	500	500	5000	0.29			
NAPHTHALENE	500	1000	3000	10000	0.59			
PHENANTHRENE	500	1000	3000	10000	5.9			
PYRENE	1000	3000	5000	10000	5.0			
SW-846 6010C/D (mg/Kg dry) Metals Digestion								
BARIUM	1000	3000	5000	10000	50	140	95	130
BERYLLIUM	90	200	200	2000	0.73	0.68	0.39	1.9
CHROMIUM (as +3)	1000	3000	5000	10000	30	36	31	37
LEAD	200	600	600	6000	25	340	1100	220
NICKEL	600	1000	1000	10000	18	32	22	29
THALLIUM	8	8	8	800	9.8	1.4	1.45	1.45
VANADIUM	400	700	700	7000	33	160	96	140
ZINC	1000	3000	5000	10000	43	250	160	190
SW-846 8082A (mg/Kg dry)								
TOTAL PCBs	1	4	4	100	2.6	13	12	7.8
SW-846 8081B (mg/Kg dry)								
4,4'-DDT	6	30	60	600	0.019	0.15	0.13	0.13
DIELDRIN	0.08	0.5	3	30	ND (0.0042)	0.16	0.19	0.16
NOTES:								
When no analyte detected, one-half reported detection limit used to calculate exposure point concentration.								

Table C-6
Identification of Method to Derive Soil Exposure Point Concentrations and Derivation of Soil Exposure Point Concentrations: Fuel Oil Vault Sands (SP-3)
(April 2016)

Parameter	Evaluation: S-2 Soils					Derivation of Exposure Point Concentration				
	Number Analyzed	Number Detected > S-2 Standard	% > S-2 Standard	Maximum Concentration	Method to Derive	Mean Concentration	Standard Deviation (Population)	95th Percentile Confidence Interval	Upper 95th Percentile Confidence Limit on the Mean	Exposure Point Concentration
Sampling Date										
Sample Depth					EPC for S-2 Soils					
MADEP-EPH-04-1.1 (mg/Kg dry)										
ACENAPHTHENE	1	0		0.70	Conc. Det'd					0.70
ACENAPHTHYLENE	1	0		0.090	Conc. Det'd					0.090
ANTHRACENE	1	0		1.5	Conc. Det'd					1.5
BENZO(A)ANTHRACENE	1	0		3.0	Conc. Det'd					3.0
BENZO(A)PYRENE	1	0		2.6	Conc. Det'd					2.6
BENZO(B)FLUORANTHENE	1	0		3.5	Conc. Det'd					3.5
BENZO(G,H,I)PERYLENE	1	0		1.4	Conc. Det'd					1.4
BENZO(K)FLUORANTHENE	1	0		1.4	Conc. Det'd					1.4
CHRYSENE	1	0		2.8	Conc. Det'd					2.8
DIBENZ(A,H)ANTHRACENE	1	0		0.59	Conc. Det'd					0.59
FLUORANTHENE	1	0		7.0	Conc. Det'd					7.0
FLUORENE	1	0		0.93	Conc. Det'd					0.93
INDENO(1,2,3-CD)PYRENE	1	0		1.4	Conc. Det'd					1.4
2-METHYLNAPHTHALENE	1	0		0.29	Conc. Det'd					0.29
NAPHTHALENE	1	0		0.59	Conc. Det'd					0.59
PHENANTHRENE	1	0		5.9	Conc. Det'd					5.9
PYRENE	1	0		5.0	Conc. Det'd					5.0
SW-846 6010C/D (mg/Kg dry) Metals Digestion										
BARIUM	4	0		140	Mean	104				104
BERYLLIUM	4	0		1.9	Mean	0.93				0.93
CHROMIUM (as +3)	4	0		37	Mean	34				34
LEAD	4	1	25.0	1100	Mean	421				421
NICKEL	4	0		32	Mean	25				25
THALLIUM	4	0		9.8	Mean	3.5				3.5
VANADIUM	4	0		160	Mean	107				107
ZINC	4	0		250	Mean	161				161
SW-846 8082A (mg/Kg dry)										
TOTAL PCBs	4	3	75.0	13	95th % UCL	8.9	4.10	4.02	12.87	13
SW-846 8081B (mg/Kg dry)										
4,4'-DDT	4	0		0.15	Mean	0.11				0.11
DIELDRIN	4	0		0.19	Mean	0.17				0.17
NOTES:										
When no analyte detected, one-half reported detection limit used to calculate exposure point concentration.										

Table C-7
Summary of Dioxin-Like PCB Congener Data for Courtyard Soil Samples
(April 2016)

Analyte	Units	B-5 (0-1')	B-7 (1-3')	B-9 (0-1')	B-11 (1-3)
Date Sampled		14-Mar-16	14-Mar-16	14-Mar-16	14-Mar-16
Sample Depth		0-1 Feet	1-3 Feet	0-1 Feet	1-3 Feet
C14-BZ#81	µg/kg	<3.8	<3.8	<3.9	<0.75
C14-BZ#77	µg/kg	<3.8	<3.8	<3.9	<0.75
C15-BZ#123/#107	µg/kg	14	32	100	<1.5
C15-BZ#118	µg/kg	210	450	1600	2.4
C15-BZ#114	µg/kg	<3.8	8.8	19	<0.75
C15-BZ#105	µg/kg	59	150	440	0.79
C15-BZ#126	µg/kg	<3.8	<3.8	<3.9	<0.75
C16-BZ#167	µg/kg	13	22	69	<0.75
C16-BZ#156	µg/kg	28	60	<3.9	<0.75
C16-BZ#157	µg/kg	8.8	17	59	<0.75
C16-BZ#169	µg/kg	<3.8	<3.8	<3.9	<0.75
C17-BZ#189	µg/kg	<3.8	<3.8	8.8	<0.75
C14-BZ#77 = 3,3',4,4'-tetrachlorobiphenyl (TCB)					
C14-BZ#81 = 3,4,4',5-TCB					
C15-BZ#105 = 2,3,3',4,4'-pentachlorobiphenyl (PeCB)					
C15-BZ#114 = 2,3,4,4',5-PeCB					
C15-BZ#118 = 2,3',4,4',5-PeCB					
C15-BZ#123 = 2',3,4,4',5-PeCB					
C15-BZ#126 = 3,3',4,4',5-PeCB					
C16-BZ#156 = 2,3,3',4,4',5-hexachlorobiphenyl (HxCB)					
C16-BZ#157 = 2,3,3',4,4',5'-HxCB					
C16-BZ#167 = 2,3',4,4',5,5'-HxCB					
C16-BZ#169 = 3,3',4,4',5,5'-HxCB					
C17-BZ#189 = 2,3,3',4,4',5,5'-heptachlorobiphenyl (HpCB)					
List of Dioxin-Like Congeners obtained from Table 2 of USEPA's <u>Recommended</u>					
<u>Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of</u>					
<u>2,3,7,8-Tetrachlorodibenzo-<i>p</i>-dioxin & Dioxin-Like Compounds,</u>					
<u>(EPA/100/R 10/005/ December 2010)</u>					
Those Dioxin-Like Congeners shown in bold text were not detected in any sample, and					
therefore, were eliminated from further evaluation in Tables 16 and 17.					

Table C-8
Calculation of TCDD Toxic Equivalence for Soil Analytical Data: Dioxin-Like PCB Congeners
(April 2016)

Analyte		Units	B-5 (0-1')	B-7 (1-3')	B-9 (0-1')	B-11 (1-3)
Date Sampled	TEF		14-Mar-16	14-Mar-16	14-Mar-16	14-Mar-16
Sample Depth			0-1 Feet	1-3 Feet	0-1 Feet	1-3 Feet
C15-BZ#123/#107	0.00003	µg/kg	14	32	100	0.75
C15-BZ#118	0.00003	µg/kg	210	450	1600	2.4
C15-BZ#114	0.00003	µg/kg	1.9	8.8	19	0.375
C15-BZ#105	0.00003	µg/kg	59	150	440	0.79
C16-BZ#167	0.00003	µg/kg	13	22	69	0.375
C16-BZ#156	0.00003	µg/kg	28	60	1.95	0.375
C16-BZ#157	0.00003	µg/kg	8.8	17	59	0.375
C17-BZ#189	0.00003	µg/kg	1.9	1.9	8.8	0.375
TEQ			1.01E-02	2.23E-02	6.89E-02	1.74E-04
Total Dioxin-Like Congeners		µg/kg	336.6	741.7	2297.75	5.815
C15-BZ#105 = 2,3,3',4,4'-pentachlorobiphenyl (PeCB)						
C15-BZ#114 = 2,3,4,4',5-PeCB						
C15-BZ#118 = 2,3',4,4',5-PeCB						
C15-BZ#123 = 2',3,4,4',5-PeCB						
C16-BZ#156 = 2,3,3',4,4',5-hexachlorobiphenyl (HxCB)						
C16-BZ#157 = 2,3,3',4,4',5'-HxCB						
C16-BZ#167 = 2,3',4,4',5,5'-HxCB						
C17-BZ#189 = 2,3,3',4,4',5,5'-heptachlorobiphenyl (HpCB)						
TEFs for Dioxin-Like Congeners obtained from Table 2 of USEPA's <u>Recommended</u>						
<u>Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of</u>						
<u>2,3,7,8-Tetrachlorodibenzo-<i>p</i>-dioxin & Dioxin-Like Compounds,</u>						
<u>(EPA/100/R 10/005/ December 2010)</u>						
TCDD = 2,3,7,8-Tetrachlorodibenzo- <i>p</i> -dioxin						
TEF = TCDD Toxicity Equivalence Factor						
TEQ = TCDD Toxic Equivalence (summation of products of congener concentration						
and TEF, for each congener <i>i</i>)						
If no congener detected for a given sample, one-half the reported detection limit						
(<#) was used as a surrogate value.						
Sample B-11 (1-3) contains a low level of PCB congeners and was not						
used for further analysis.						

Table C-9
Comparison of Total Dioxin-Like PCB Congeners to TCDD Equivalence and Total PCB Congeners
(April 2016)

Analyte	Units	B-5 (0-1')	B-7 (1-3')	B-9 (0-1')
Date Sampled		14-Mar-16	14-Mar-16	14-Mar-16
Sample Depth		0-1 Feet	1-3 Feet	0-1 Feet
Total PCB-Congeners (Table 8)	mg/kg	3.3853	6.7551	22.2447
Total Dioxin-Like Congeners (Table 16)	mg/kg	0.3366	0.7417	2.29775
Dioxin-Like Congeners, as a percent of Total PCB-Congeners	%	9.9	11.0	10.3
TCDD Toxic Equivalence (Table 16)	mg/kg	1.01E-05	2.23E-05	6.89E-05
TCDD Toxic Equivalence as proportion of Total PCB-congeners		2.98E-06	3.30E-06	3.10E-06
Reference: USEPA's Recommended Toxicity Equivalence Factors				
(TEFs) for Human Health Risk Assessments of				
2,3,7,8-Tetrachlorodibenzo- <i>p</i> -dioxin & Dioxin-Like Compounds,				
(EPA/100/R 10/005/ December 2010)				
TCDD = 2,3,7,8-Tetrachlorodibenzo- <i>p</i> -dioxin				
TEF = TCDD Toxicity Equivalence Factor				
TEQ = TCDD Toxic Equivalence (summation of products of congener concentration				
and TEF, for each congener <i>i</i>)				

Table C-10
Calculation of Dioxin-Like PCB Congener Exposure Point Concentrations, as TCDD Equivalence
(April 2016)

Exposure Point	Units	PCB Exposure Point Concentration	Fraction as TCDD-Like PCBs	TCDD-Like PCB Concentration	TEF for all dioxin-like congeners*	TCDD-Like PCB Exposure Point Concentration
			unitless		unitless	
0-1 Foot Interval	mg/kg	41	0.11	4.51	3.00E-05	1.35E-04
1-3 Foot Interval	mg/kg	7.6	0.11	0.836	3.00E-05	2.51E-05
3-6 Foot Interval	mg/kg	1.9	0.11	0.209	3.00E-05	6.27E-06
3-11 Foot Interval	mg/kg	2.0	0.11	0.22	3.00E-05	6.60E-06
Fuel Oil Vault Sands (SP-3)	mg/kg	13	0.11	1.43	3.00E-05	4.29E-05
Reference: USEPA's Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8-Tetrachlorodibenzo- <i>p</i> -dioxin & Dioxin-Like Compounds, (EPA/100/R 10/005/ December 2010)				* All detected TCDD-like PCB congeners had the same TEF value of 0.00003 (3.00E-05), which simplified the calculation of EPCs for dioxin-like PCBs.		
				EPC = Exposure Point Concentration		
TCDD = 2,3,7,8-Tetrachlorodibenzo- <i>p</i> -dioxin						
TEF = TCDD Toxicity Equivalence Factor						
TEQ = TCDD Toxic Equivalence (summation of products of congener concentration and TEF, for each congener <i>i</i>)						

Table C-11
Comparison of Risk Estimates to MCP Risk Limits
(April 2016)

Receptor	Exposure Point	Soil Interval (feet)	ELCR	Cancer Risk Limit	Significant Risk of Harm?	HI	Non-Cancer Risk Limit	Significant Risk of Harm?
Construction / Utility Worker	Courtyard	0 - 1	2.1E-06	1.E-05	No	3.2	1	Yes
	Courtyard	1 - 3	5.6E-07	1.E-05	No	1.0	1	No, but close
	Courtyard	3 - 6	1.8E-07	1.E-05	No	0.29	1	No
	Courtyard	3 - 11	1.8E-07	1.E-05	No	0.31	1	No
	Fuel Oil Vault Sands	Stockpile SP-3	7.7E-07	1.E-05	No	1.3	1	Yes
Resident	Courtyard	0 - 1	3.1E-05	1.E-05	Yes	9.4	1	Yes
	Courtyard	1 - 3	8.5E-06	1.E-05	No	3.1	1	Yes
	Courtyard	3 - 6	2.7E-06	1.E-05	No	0.87	1	No
	Courtyard	3 - 11	2.7E-06	1.E-05	No	0.91	1	No
	Fuel Oil Vault Sands	Stockpile SP-3	1.2E-05	1.E-05	Yes	4.0	1	Yes

ASSUMPTIONS:

NO SINGLE FAMILY RESIDENCE. NO GARDENING OF EDIBLE PRODUCE.

EXPOSURE TO SOILS OCCURS ONLY DURING A SINGLE SIX-MONTH CONSTRUCTION PROJECT, AFTER WHICH TIME THE SOILS ARE RETURNED TO EXCAVATION OR ARE TRANSPORTED OFF-SITE.

ASSUME **NO** CONTROLS ARE USED TO LIMIT RESIDENTIAL EXPOSURE TO SOILS DURING CONSTRUCTION PROJECT.

PROTECTIVE COVER MUST REMAIN OVER SOILS EXCEPT DURING CONSTRUCTION OR UTILITY PROJECT, AFTER WHICH TIME THE PROTECTIVE COVER MUST BE RE-INSTALLED.

IF CONTROLS ARE USED TO LIMIT RESIDENTIAL EXPOSURE TO SOILS DURING CONSTRUCTION PROJECT, THERE WOULD BE NO SIGNIFICANT RISK OF HARM FOR 1-3 FOOT INTERVAL, BUT IT WOULD BE CLOSE TO NON-CANCER MCP RISK LIMIT.